FOREST STEWARDSHIP PLAN
for
Foy's Community Forest

October 30, 2007
Updated March, 2012
Updated November, 2013

Prepared By

NORTHWEST MANAGEMENT, INC.

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Landowner Information

Flathead County, Montana
800 South Main Street
Kalispell, MT 59901

Flathead County Parks Department
309 FFA Drive
Kalispell, MT 59901
406-758-5800

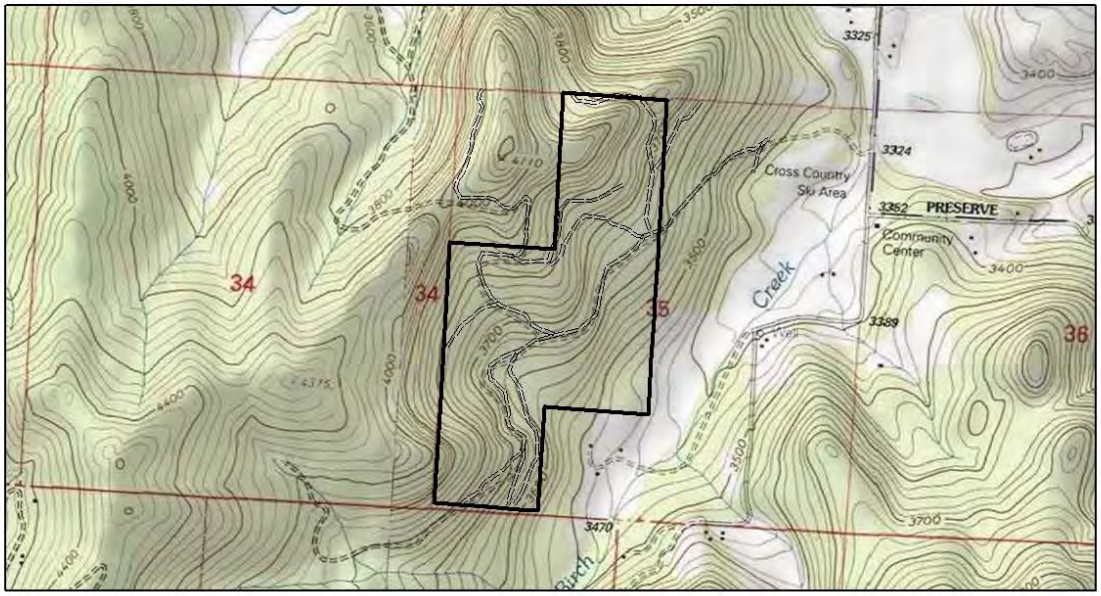
The property is owned by Flathead County as part of the county park system and managed according to this managment plan, the Flathead County Parks Plan, the Flathead County Trail Plan, and the Flathead County Weed Plan. The property is under the jurisdiction of the county Weed and Parks Department, Jed Fisher Director.

Property Location

The subject property is located in Flathead County, approximately 3 miles southwest of Kalispell, Montana. From the junction of Highway 93 and Highway 2 in Kalispell proceed west on Highway 2 to the interesection of Meridian Road. Turn left onto Meridian Road and continue beyond Foy's Lake approximately 1 mile to Herron Park. The property is accessed by a forest road which begins at a locked gate on the Park's east boundary or from a paved parking lot further south. The property is bounded to the east by Herron Park; Plum Creek Timber Company borders a portion of the southern boundary; and homesites and private forest land bound the remainder of the property.

Property Vicinity Map

Foy's Community Forest Property
T28N, R22W PMM
Flathead County, Montana



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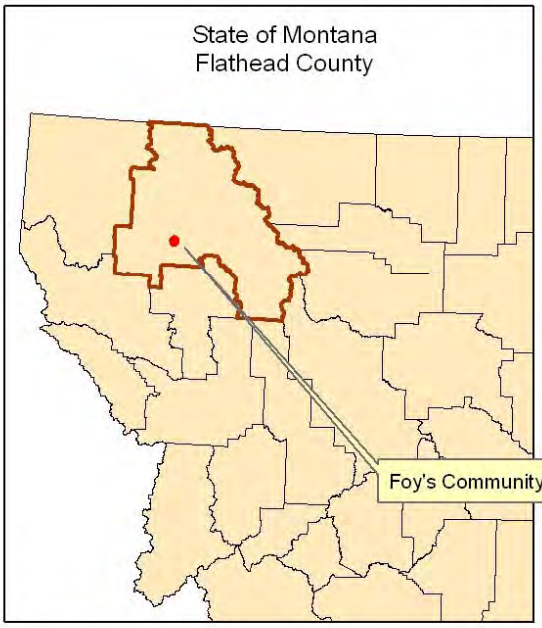

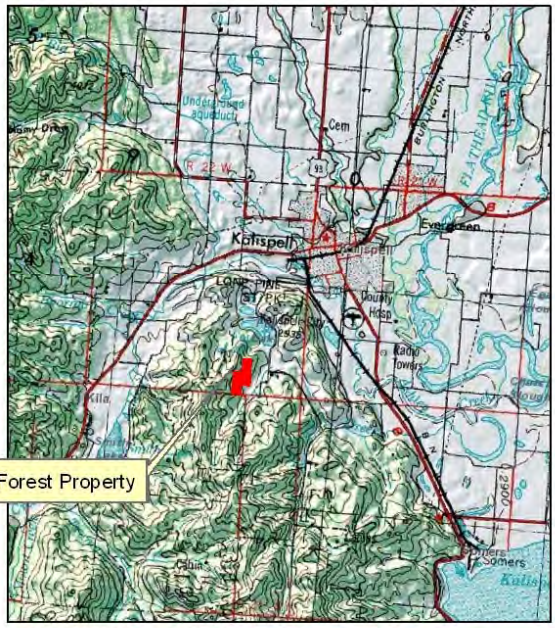

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Legal Description of Subject Lands
Portion of Section 35, Township 28 North, Range 22 West as follows: Tract 2A in the E1/2W1/2 and Tract 5B in W1/2W1/2.

Total area of the property is approximately 218.09 acres.

Surrounding Land Use
The land surrounding the subject property includes privately owned rural/residential forested tracts, pasture land, a County Park, and industrial forest land.

Ownership Map

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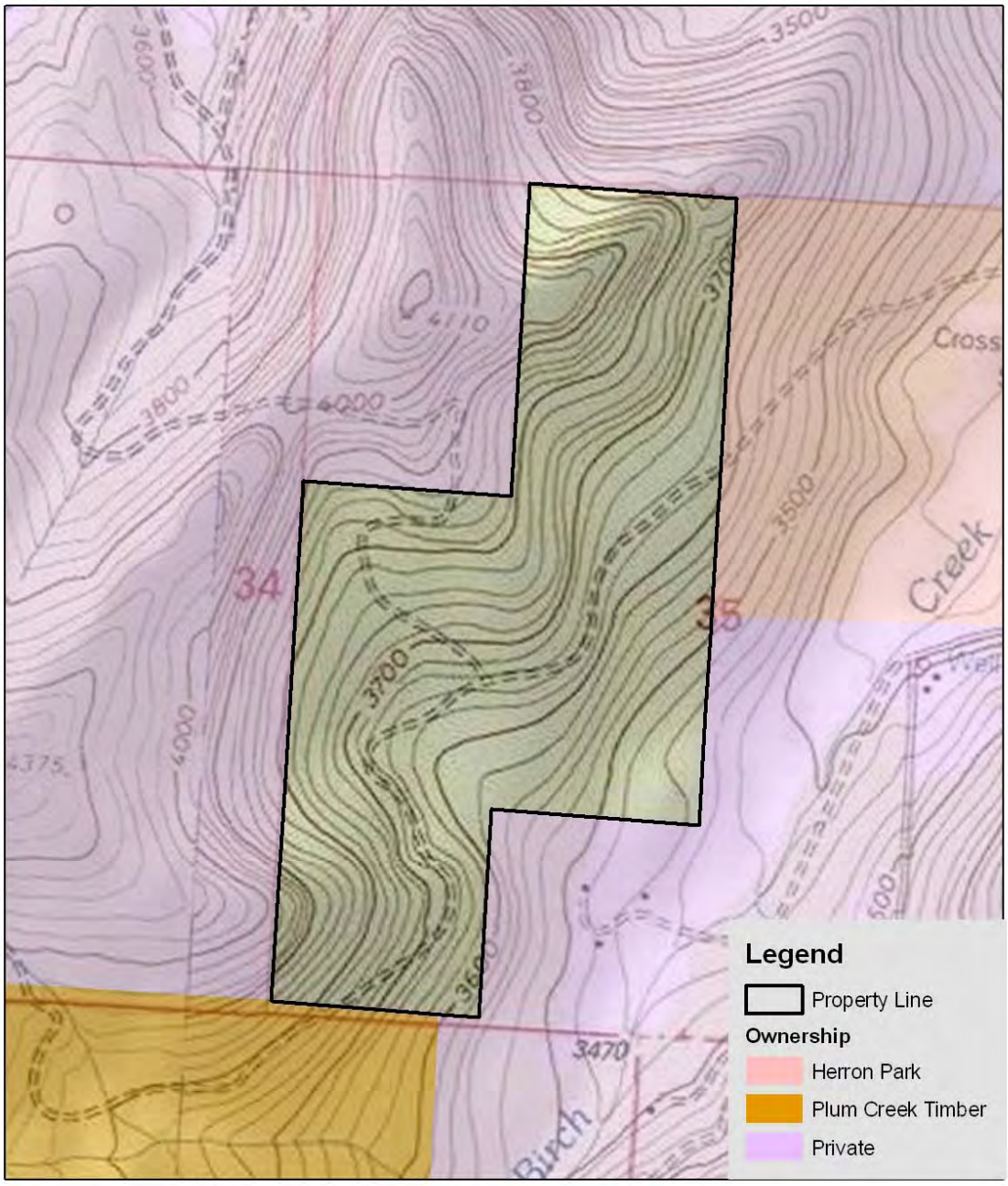
Flathead County, Montana



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Property Description

Topography

The property is moderately to steeply sloped with the elevations ranging from approximately 3,450’ above sea level along east property boundary to 3,990’ above sea level on a ridge top located on the west boundary of the property. The predominate slope aspects on the property are east and southeast though a north aspect is present on the north half of the property. Three dominant ridges descend through the property. A ridge on the northern one-third of the property ridge descends in a northeastery direction from the west boundary. A broad ridge on the central portion of the property descends to the southeast from the west boundary. On the southern third of the property a steep ridge descends from the west boundary to the east. There are no streams on the property.

Topographic Map

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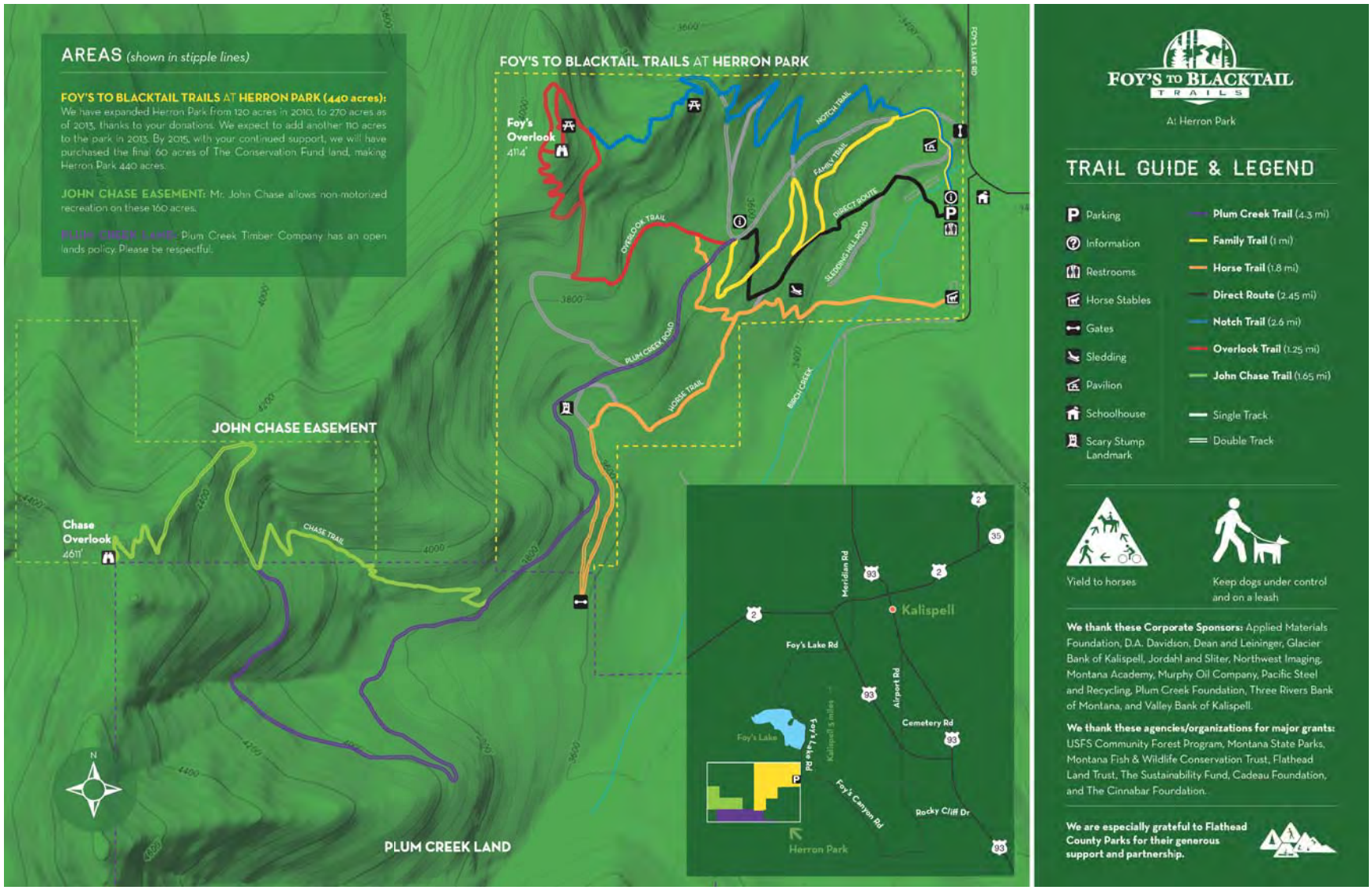
Road Access

A mid-standard native surfaced forest road accesses the northeast portion of the property from Foy's Lake Road and continues in a southwesterly direction exiting the property near the southwest property corner. The road is suitable for highway vehicles and large truck traffic. This road has deeded access easements for Plum Creek Timber and John Chase. Several lower standard native surfaced spur roads on the property ascend from the main road to the north providing good road access to the remainder of the property. These roads also provide access for log trucks and other high clearance vehicles.

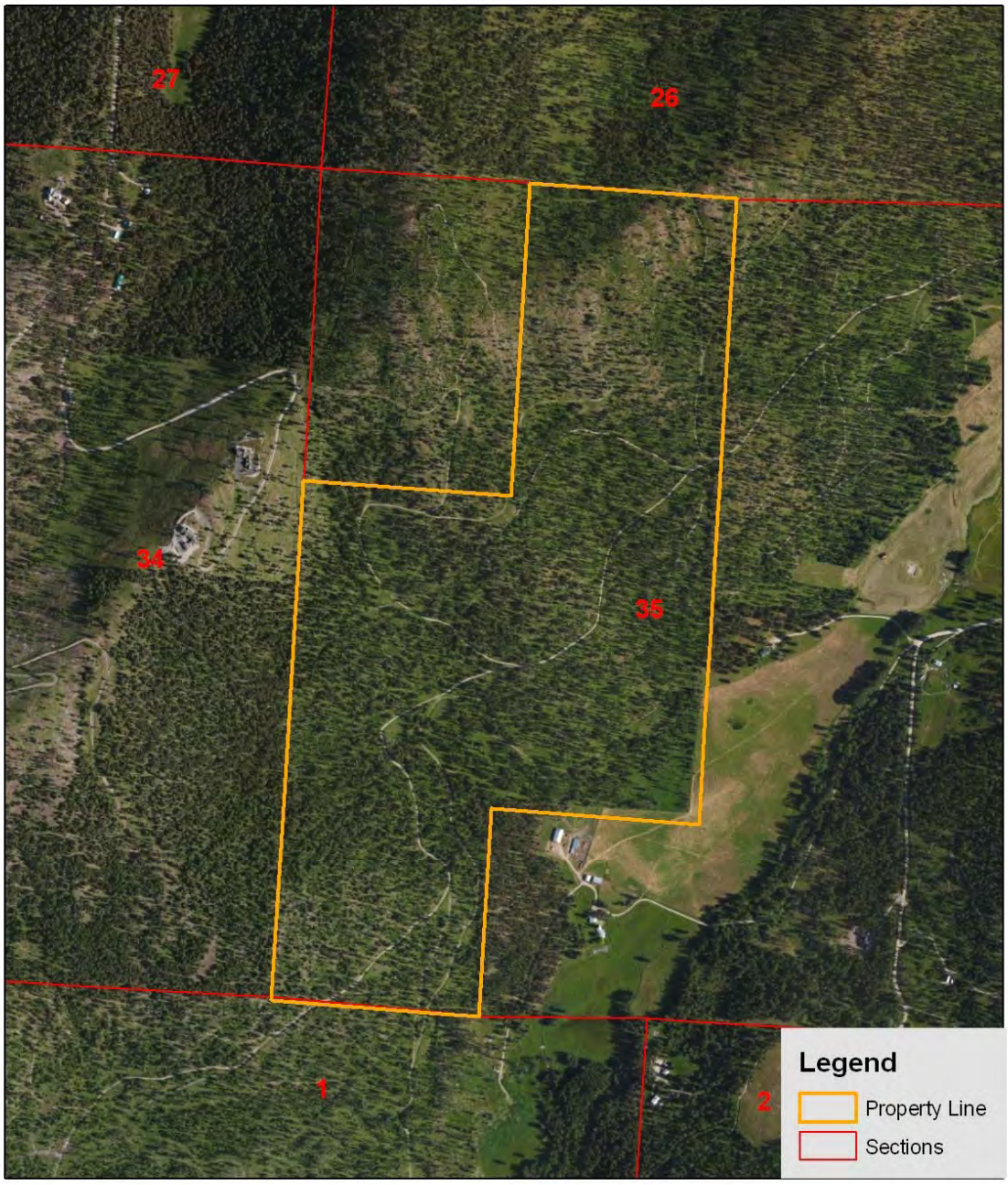
Trails

In addition to roads, there are numerous multi-use, full season (horse/mountain biking/hiking/ski/snowshoe) trails which loop within the property. The property is open to the public and dispersed non-motorized recreation is a high priority for this forest. The trail system is constructed and maintained by the non-profit volunteer group Foy's to Blacktail Trails and Montana Conservation Corps in partnership with Flathead County. (www.FoysToBlacktailTrails.org)


AREAS (shown in stipple lines)
FOY'S TO BLACKTAIL TRAILS AT HERRON PARK (440 acres):
We have expanded Herron Park from 120 acres in 2010, to 270 acres as of 2013, thanks to your donations. We expect to add another 110 acres to the park in 2013. By 2015, with your continued support, we will have purchased the final 60 acres of The Conservation Fund land, making Herron Park 440 acres.
JOHN CHASE EASEMENT: Mr. John Chase allows non-motorized recreation on these 160 acres.
PLUM CREEK LANDS: Plum Creek Timber Company has an open lands policy. Please be respectful.
FOY'S TO BLACKTAIL TRAILS AT HERRON PARK
Foy's Overlook 4114'
NOTCH TRAIL
FAMILY TRAIL
DIRECT ROUTE
SLEDDING HILL ROAD
OVERLOOK TRAIL
PLUM CREEK ROAD
HORSE TRAIL
BIRCH CREEK
FOYS LAKE RD
JOHN CHASE EASEMENT
Chase Overlook 4611'
CHASE TRAIL
PLUM CREEK LAND
N
Kalispell
Meridian Rd
Foy's Lake Rd
Airport Rd
Cemetery Rd
Foy's Canyon Rd
Rocky Cliff Dr
Herron Park
Foy's Lake
Kalispell 5 miles
FOY'S TO BLACKTAIL
TRAILS
At Herron Park
TRAIL GUIDE & LEGEND
Parking
Information
Restrooms
Horse Stables
Gates
Sledding
Pavilion
Schoolhouse
Scary Stump Landmark
Plum Creek Trail (4.3 mi)
Family Trail (1 mi)
Horse Trail (1.8 mi)
Direct Route (2.45 mi)
Notch Trail (2.6 mi)
Overlook Trail (1.25 mi)
John Chase Trail (1.65 mi)
Single Track
Double Track
Yield to horses
Keep dogs under control and on a leash
We thank these Corporate Sponsors: Applied Materials Foundation, D.A. Davidson, Dean and Leininger, Glacier Bank of Kalispell, Jordahl and Sliter, Northwest Imaging, Montana Academy, Murphy Oil Company, Pacific Steel and Recycling, Plum Creek Foundation, Three Rivers Bank of Montana, and Valley Bank of Kalispell.
We thank these agencies/organizations for major grants: USFS Community Forest Program, Montana State Parks, Montana Fish & Wildlife Conservation Trust, Flathead Land Trust, The Sustainability Fund, Cadeau Foundation, and The Cinnabar Foundation.
We are especially grateful to Flathead County Parks for their generous support and partnership.

2011 Aerial Photograph

Foy's Community Forest Property
T28N, R22W PMM
Flathead County, Montana



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Forest Management Goals

Ownership Goals List

This Forest Stewardship Plan will address forest management goals for Foy's Community Forest. Forest management goals are listed below in relative order of importance as identified by the property owners.

- Provide outdoor recreational opportunities for the public.
- Provide opportunities for public education regarding scientifically sound forest management.
- Maintain an aethetically pleasing forest environment.
- Improve forest health, tree vigor and tree growth rates.
- Reduce risk of catastrophic wildfire.
- Control noxious weeds.
- Maintain or improve wildlife habitat.
- Periodically harvest timber at a sustainable level.
- Maintain or improve water quality.
- Obtain periodic income from the sale of wood products.

Goals Discussion

Ownership goals are given primary consideration during the development of recommended forest management actions. For the purposes of this Stewardship Plan, forest management recommendations are made by stand type. A minimum 10-year planning horizon is considered in terms of planning management activities. In some cases a longer planning horizon may be necessary in order to achieve certain goals. Specific stand recommendations are designed to be realistic and achievable based upon the physical limitations of the specific site (topography, soils, elevation, access, and aspect), financial considerations, and biological constraints. It may not be possible to achieve every goal on every acre, but stand recommendations will identify where significant potential exists to achieve one or more of the ownership goals. Some general statements can be made in regards to the forest management goals listed above.

- **Provide Outdoor Recreational Opportunities for the Public**

Recreation History

The Civilian Conservation Corps built Forest Service Trail 71A prior to 1938. This trail runs from Herron Park to the top of Blacktail Mountain and served as an alternate mule train supply route for a fire lookout on Blacktail Mountain before there were any roads in the area. It is this trail that sparked the formation of the non-profit Foy's to Blacktail Trails in 2001 to attempt to protect this long standing public access between two public properties. Yet to be completed is a dedicated easement across private timberland between the two public properties. If this trail is completed as envisioned the Community Forest will serve as the northern anchor while the Island Unit of the Flathead National Forest will serve as the southern anchor.

In 1978, Flathead County acquired 120 acres from the Herron family, creating Herron Park. The following year Flathead Combined Training, a local horse group, began doing improvements at the park and providing general maintenance services such as grass cutting and weed control. These efforts grew into development of a full three day eventing course and a 60 stall barn; completed with private funds and volunteers. These amenities attract numerous horse events each year. Flathead Combined Training continues to be active in Herron Park and horses are a

major component of the user base. It is believed that the size and quality of the horse facilities on the property are unique in the country for a public park. It is important that the historic precedence of equine use is recognized and carefully considered in user management.

Over the years a user created trail system grew within the forested areas of Herron Park and the adjacent private property that is now Foy's Community Forest. In fact most users were unaware that the adjacent private property was not part of the park. This user created trail system was unplanned, haphazard, unsustainable, and not recognized or maintained by the county. In 2009 Flathead County Parks and Foy's to Blacktail Trails were awarded a MT State Parks Recreational Trails Program grant to plan and construct a new trail system in the 440 acre project area. To date all but one of these planned trail segments have been constructed, resulting in a significant increase in user days and satisfaction. Herron Park/FCF has become a regional destination for recreation and host to numerous sporting events that help support the local economy.

Recreation Assets

Herron Park and Foy's Community Forest are fully open to the public for year-round non-motorized recreation. The trail system currently has no user restrictions or closures. The user base and local community appreciate the lack of restrictions and desire that this will continue into the future through sound management and user group cooperation.

The trail system was designed to attract certain users to particular trails, fostering a natural segregation. The Family Trail is attractive to social hikers, beginning hikers, families with small children and seniors. The Notch Trail is attractive to bicycles, fitness hikers and trail runners. The Horse Trail is intended to move horses from the stable area to adjacent commercial timberland with minimal connection to other trails and potential conflicts. For the system to work properly it is necessary for users to be aware of this natural segregation. Bicycles are not banned from the Family Trail but should travel slowly and in control when using it. Horse riders should be aware that they will encounter bicycles and runners on the Notch Trail and avoid this trail if that will be a problem for them.

Winter trail grooming for skiing and snowshoeing has a long history at Herron Park and the FCF property. This practice is immensely popular with the public and makes possible winter events. The last few years Plum Creek has allowed grooming of their road system, increasing available trail miles considerably.

The sledding hill is a very popular winter destination for families. With assistance from FVCC the natural hill that is currently used could be graded and improved, not only for sledding safety but for summer drainage and erosion control.

Herron Park and the Community Forest are a popular place to walk and run with dogs. Individuals, couples, and families of all ages are frequently seen with one or more dogs in tow.

Frisbee golf has been played in the area for years utilizing a user created course of painted trees and rocks. The park area is an ideal landscape for a formal course with manufactured baskets.

Recreation Goals
Many trail users are seniors and families with small children. These groups appreciate places to sit and rest, or to simply enjoy the scenery. It is recommended that numerous benches be provided along trails. Benches could be as simple as large rocks or log segments. These materials are serviceable, inexpensive, durable and fit with the wildland aesthetic of the property. Several trails were constructed with wide spots at scenic overlooks specifically for bench placement.

Herron Park and the Community Forest are popular for sporting events that attract participants from outside the area, providing a boost to the local economy. This is a positive trend that should be encouraged and supported via staff time and infrastructure development.

The public has shown a strong interest in volunteering to work in the Community Forest. In addition to ongoing volunteer work there are two major volunteer days, National Trails Day and National Public Lands Day, where the general public is invited. Participation has been strong and growing, not only from individual users but from service organizations and schools. These work days get much needed work completed at no cost to the taxpayer. However, Flathead County has a restrictive and ambiguous volunteer policy. The county is discouraging volunteers that want to improve the public land they love to play on. This volunteer labor and skill has a high monetary value and give the public a personal interest in their public spaces. A more friendly and open policy toward volunteers will result in increased stewardship by trail users.

Recreation Challenges
Horses have historic precedence in the area and the horse groups have invested heavily in park infrastructure. Having horses present in a general, dispersed recreation environment is a particular challenge. Many of the horses and riders using the area are green and are there for training. Other user groups must be continually informed of their responsibilities when recreating with horses and that horses always have right of way.

Some trails in the county have included banked turns and jumps for bicycles. While this is fun for the bike user it promotes high speeds that are dangerous to other users and converts these trails to a single user group. A dedicated bicycle trail is envisioned in the trail plan but has yet to be constructed. Such challenge features could be appropriate for a dedicated bike trail but are not appropriate for mixed use trails.

Communication is the primary key to resolving user conflict. User groups should communicate with each other concerning management of the property and experienced users should politely inform new users of established trail etiquette. A new, attractive trailhead kiosk, slated for erection in 2014, will contain trail safety information that will explain trail etiquette and right-of- way- protocols.

- **Provide Public Education**

Education Opportunities
Foy's Community Forest will serve as an outdoor classroom for forest stewardship education and wildland ecology. Education opportunities exist for area schools and a diverse array of local and regional citizen groups. A variety of "target audience groups" have been indentified including students from pre-kindergarten through college, adults, and forest landowners in the

Wildland/Urban interface. Specific educational opportunities for each target audience group are being actively developed through existing frameworks and organizations.

Examples of specific school based target groups include but are not limited to: local elementary, middle, and high school aged students; Flathead Valley Community College students and Confederated Salish and Kootenai tribal college students.

Public sector target groups include but are not limited to: forest landowners, lay citizens interested in forest management, civic and non-profit groups such as Boy/Girl Scouts, environmental learning center groups and clubs, tourists and visitors to the Flathead Valley, recreationalists and other outdoor enthusiasts.

Many of these groups currently utilize FCF for recreation and informal or independently structured education programs. However, there is a desire on the part of the community to develop more structured education programs.

Education Assets

Location and Year Round Access - The forest is located a few minutes drive from downtown Kalispell. Access is via State Highway 503, Foy's Lake Road, provides year-round access to a paved parking lot with two wheelchair compatible vault toilets. There is ample space for parking buses, vans and other vehicles necessary to transport groups.

Foy's Community Center - This County owned and maintained facility is located directly across the street from the park entrance and parking area. It has meeting space, kitchen, and restroom facilities available to groups.

Existing Trail and Road System - A high quality system of trails provide access to various locations throughout the property. These trails are designed and maintained for recreation but provide excellent access for education purposes. The trails are well signed and published trail guides are available. There is a gated forest road that traverses the property and is suitable for motor vehicles and small busses. This road provides vehicle access to forest areas at upper elevations for organized groups and those who cannot travel by other means.

Lone Pine State Park and Visitor Center - Lone Pine State Park is located within 2 miles of Foy's Community Forest. The visitor center is open year-round and provides an interpretive tour of the wildlife and forest ecology within the park. The visitor center contains a spacious meeting/classroom with audio visual equipment. Regular adult workshops, children's activities and interpretive programs make Lone Pine a regular destination for school field trips, residents and out-of-state visitors. Lone Pine is a valuable and important Community Forest education partner. The combined properties provide schools with a broader and richer learning environment in a single outing.

Forest Environment - The FCF includes low-elevation forest lands that have been actively managed for timber production since the turn of the 19th century. These lands are representative, in terms of management history and forest ecology, of many private forest tracts in NW Montana. This forest environment provides opportunities to study wildlife habitat and

management, forest restoration and management, wildfire hazard abatement, weed control, forest pest management, plant identification, cultural values, recreational use and management, aesthetics, and many other topics.

Riparian/Wetland and Meadow Environment - The riparian/wetland environment present along ephemeral Birch Creek is known to support one of two populations of Northern Leopard Frogs found in western Montana. It also supports a resident population of Western Toads. Both of these amphibians are identified as species in greatest need of conservation in Montana's fish & wildlife conservation strategy. There are opportunities to study the maintenance and restoration of riparian habitats required by the Northern Leopard Frog on and adjacent to the Foy's Community Forest. Both the meadow and riparian/wetland environments are easily accessible from roadways and trails near the property entrance and parking lot.

Education Target Audiences

Initial collaborative efforts indentified multiple target audience groups that can be broadly divided into two audiences: Adults and School-Aged Children. While sharing some common needs there are distinguishing requirements that separate the two groups.

Adults - Adults tend to seek education opportunities that will help them be more successful in activities of their own choosing. Adults will often be internally motivated and take advantage of self-directed learning opportunities, seeking education opportunities to help them better cope with real-life tasks or problems. Organized tours to field demonstration sites will likely involve the use of existing forest roads and require the construction of small parking and turn-around areas for mini-busses or vans.

School-Aged Children - This target audience requires good access to developed interpretive areas. Student groups must be able to walk a short distance from parking and bathroom facilities to designated learning points. Development of site specific curriculums and learning guides will assist teachers who are leading student groups. Experiential learning is an integral component of outdoor education for children so "hands on" activities are important for this audience. Approaches to this form of education might emphasize projects, games, activities and structured curriculums.

Targeted Education Opportunities

Numerous education approaches can be specifically developed for these two audiences, such as:

- Demonstration Sites and Case Studies
- Mentored Learning Activities
- Site Specific Curriculums
- Applied Research and Monitoring Activities
- Guided Interpretive Activities
- Self-Guided Interpretive Trails, Tours, Brochures, Signage and Activities
- Outdoor Classroom Sessions and Workshops
- Hosted Events

Education Plan Implementation

The science of forestry and ecology is continually changing and improving as the understanding of the complex systems of nature evolve. Programs that intend to teach these subjects must also be capable of adaptation and be cost effective. The following tools have been identified to assist in the teaching goals of FCF.

- A permanent interpretive trail designed primarily for grade school students
- Self guided "podcast" audio tours with different levels of complexity
- Demonstration projects and Areas
- Outdoor classroom, direct school involvement

Interpretive Trail - The eight-tenth-mile interpretive trail will start and end at the main parking lot. The trail will utilize the Lower Family Trail and return across the meadow. Most of this route is currently less than 5% grade and can be improved for wheelchair access if necessary. Teaching tools will consist of permanent signage and podcast audio. The focus is to provide a permanent trail for teaching Project Learning Tree modules. The return trail across the meadow crosses the ephemeral Birch Creek drainage. The interpretive trail can be expanded in scope by executing a wetlands planting project along the drainage. Planting and management should be performed by school children and be ongoing.

Outdoor education and forestry professionals have developed an initial site plan for the interpretive trail. An existing logging deck in the forest will be improved for use by student groups by clearing brush, leveling and installation of a circle of log benches. An existing logging access road has been improved to provide limited vehicular access to the site. Future considerations may include the construction of a small pavilion.

"Podcast" Audio Tours - Develop a set of self-guided, smart phone based audio tours. Professionals in forestry and biology will go to specific, interesting locations in the forest and discuss that site's potential importance to wildlife, how it may be susceptible to wildfire, or how it could be managed to achieve various goals. The underlying premise is to demonstrate the complexity of forestry management, and how to recognize and balance competing/conflicting goals. There will be lectures of increasing complexity for different target audiences such as grade school students, high school students, lay public or working Tree Farmers. It is desirable to work with the Confederated Salish and Kootenai tribe to develop a cultural component. A map will guide users to site locations where they will click on a bar code sign that connects them to a specific audio lecture on the Internet. This format is preferred to a printed booklet due to the flexibility of message and low cost to implement and maintain.

Demonstration Projects and Areas - FCF is a working forest that will periodically harvest trees, and perform forest maintenance and restoration work. These are excellent opportunities to teach by getting the public involved in the planning process; for example why mistletoe infected trees should (or should not) be removed, or why a FireWise thinning should be implemented. It is also an excellent opportunity for the public to actually watch an operation in progress with qualified speakers on hand for explanation and discussion. Local loggers and contractors can use this opportunity to showcase their skills and solicit business.

Demonstration Projects become Demonstration Areas that are part of the audio tour. For example, someone interested in FireWise can go to that site and hear a lecture on how to manage for fire safety in the Wildland/Urban Interface. Demonstration Areas can be used by consulting and DNRC Service Foresters to inform clients about various management options so they can make better decisions.

Outdoor Classroom, Direct School Involvement - Work with local teachers and professors to encourage use of FCF as an outdoor classroom and conversely develop infrastructure that will be useful to teachers. Examples include:

- Develop the Interpretive Trail to address specific Project Learning Tree modules and host teacher training days for those modules.
- Develop relationships with individual teachers to address their specific teaching needs, currently a FVCC professor utilizes FCF as part of her Field Botany course.
- Work closely with Lone Pine State Park so the two areas are complementary and offer a wide range of opportunities to local schools in a single field outing.

- **Forest Aesthetics**

Because of heavy public use, and association with and proximity to Herron Park, forest aesthetics are very important. In teaching active forest management it is vital to demonstrate that a forest can work without appearing defeated. Snags, large legacy trees, malformed and broken top trees will be left for forest diversity, wildlife habitat and visual aesthetic.

- **Improve Forest Health**

Forest health problems on the subject property are limited in extent at this time. Moderate to severe damage from dwarf mistletoe infection is evident in the Douglas-fir on the poorer sites.

Limited damage from pine beetles was observed. Annual monitoring for beetle outbreaks and infestations should occur on an regular basis so appropriate responses can occur in a timely manner. Silvicultural prescriptions developed for stands with a significant component of ponderosa pine should be designed to decrease the potential for pine beetle infestations.

Forest health and tree growth rates at the stand level can be maintained or improved by controlling tree stocking levels, tree species diversity and forest stand structure. Stand improvement recommendations should identify the preferred retention tree species for various stand types. Stand improvement practices which emphasize retention of trees exhibiting superior form and growth rates will improve the productivity of forest stands over time. In some cases other management objectives such as wildlife habitat may override the objective of maintaining tree growth for periodic income.

- **Reduce Risk of Catastrophic Wildfire**

Risk of wildfire is always a concern, not only are economic issues at stake but also environmental consequences and damage to recreation/education assets. While risk of wildfire cannot be eliminated, the implementation of recommended forest management practices can significantly reduce the potential for a catastrophic wildfire and be used to demonstrate wildfire hazard reduction practices to the public. Recommended management practices should always consider issues such as fuel loading and slash disposal, maintenance of fire resistant forest stand structures, and retention of tree species resistant to low intensity wildfire. Maintenance of a usable road system will provide ready access should fire suppression activities be required.

- **Control of Noxious Weeds**

The predominant weeds on the property are knapweed, thistle, St. John's wort and houndstongue burr. Weed colonies are mapped and sprayed annually. This must be an ongoing program.

Noxious weeds are a serious ecological and environmental threat to the natural resources of Montana. Noxious weeds displace native plant communities, alter wildlife habitat, reduce forage for wildlife, and lower biodiversity.

Noxious weed control can be a major expense. Methods of control include prevention, herbicide treatments, utilization of biological controls, and grass seeding. Forest roads, on and off road vehicles, and timber harvesting equipment are primary vectors of dispersal for weeds. Recently disturbed soils are especially vulnerable to colonization by weeds and should be seeded with an approved seed mix at the earliest appropriate time. Weed prevention strategies must be considered in regards to every management action taken. There must be an ongoing effort to

monitor weed populations (especially on roads and recently disturbed areas), identify weed species and stay informed regarding innovative management strategies. All visitors and workers who enter the property should be informed and made aware of weed management practices.

- **Maintain or Improve Wildlife Habitat**

Especially important forest wildlife habitat components include large diameter, dead, standing and down trees, riparian and upland shrubs, and native bunchgrasses. Availability of hiding and thermal cover should be considered at both the landscape and stand level. Multi-layered forest structures generally provide habitat for the widest array of wildlife species. However, some wildlife species will favor dense single stand structures while other species prefer a more open forest structure or one with multiple forest openings. Forest landscapes which provide an mosiac of vegetation types and structure will support the greatest array of wildlife species.

Wildlife habitat concerns are often best addressed by emulating the natural disturbance regimes that have shaped forest habitats over the past several centuries. It is important to understand the habitat requirements of specific wildlife species and manage for conditions that provide the necessary critical habitat components. In some instances forest management practices must be modified to achieve wildlife related objectives. Key wildlife habitat components that are lacking should be addressed in the development of recommended stand treatments. Wildlife management professionals can be consulted to provide professional guidance and to evaluate the condition and trend of wildlife habitats. These issues are especially significant in and near riparian areas and wetlands due to the dependence of many wildlife species on these habitats. Timing of management actions should be considered to reduce impacts to wildlife at critical times of the year such as breeding, nesting and birthing seasons and winter months when animals may be stressed.

- **Harvest Timber at a Sustainable Level**

Collection of forest inventory data and tree growth rate information as well as a determination of what portion of the timber base is available for harvesting is required to accurately determine the rate at which timber can be harvested on a long-term sustainable basis. This plan represents a first step towards determining what level of harvest is sustainable over the next several decades. A preliminary timber volume estimate is provided based on forest stand classification and the total number of forested acres represented by various stand types. Forest management recommendations in this plan will reduce the potential for loss of commercial timber to insects and diseases, wildfire and tree mortality. A comprehensive forest inventory is lacking but could be produced via grants and cooperation with agencies and local schools.

- **Maintain or Improve Water Quality**

The most significant potential impact to water quality in managed forests is sediment. The most significant potential source of sediment is runoff from forest roads. Another common source of sediment is erosion associated with timber harvest. Forest roads should receive special consideration regarding proper design, drainage, and stream crossing infrastructure. Ongoing forest road maintenance is required on roads subject to erosion. Adherence to Forestry Best Management Practices and installation of Streamside Management Zones during timber harvesting activities will significantly reduce the potential for sedimentation. It is recommended

that forest roads be inventoried and rated for compliance with BMP standards, and a plan be developed for improving non-compliant sections.

- **Obtain Periodic Income from the Sale of Wood Products**

Income production from the sale of wood products is an important goal for any landowner wishing to hold, maintain and improve their forested property. Traditional wood product markets for sawtimber, house logs, pulpwood, firewood, and hog fuel are currently available. There are several sawmills located resonable distances from property. Wood product market values, transportation costs and logging costs will determine when it is economically feasible to harvest and sell wood products.

Aggressive management of overstocked young forest stands on productive, accessible sites will shorten the length of time required for trees to grow to sufficient size to be marketed and sold as higher value forest products. Management of non-merchantable sized trees will typically involve investment in pre-commercial thinning and slash disposal. Pulpwood markets may provide limited opportunities to offset costs associated with some forest improvement treatments. Future markets for biofuels may develop but opportunities remain limited at this time.

A good road infrastructure provides access to a majority of the property and therefore costs associated with the development of roads are not a significant concern.

By establishing goals, adhering to them, and employing a management strategy adaptive to changing conditions, the timber base should continue to provide a reliable source of income into the future.

Historical Forest Management on the Property

Recent Timber Management Practices

A selective timber harvest was conducted on the property in 1996 for wildfire hazard reduction and forest health improvement. Several stands on the north half of the property were hand planted during the past decade to improve stocking levels and maintain species diversity. Adequate natural regeneration exists over most of southern half of the property.

Historical Overview of Fire History and Stand Development

Prior to the 1800's widely spaced, large diameter ponderosa pine, western larch, and Douglas-fir trees likely dominated the low elevation forests of the Flathead Valley. Forests in this condition are difficult to find today due to the combined effects of wildfire suppression and a history of timber harvest which emphasized the removal of the largest, most valuable trees.

Historically, the structure and species composition of low elevation forests was strongly influenced by low intensity fires that occurred at a frequency of approximately every 5-20 years. Most fires burned only the grasses, forbs, brush, and small trees. The thick bark of mature trees protected them from heat damage and as a result most large trees survived. When organic debris accumulated in the forest, the fire intensity increased and individual mature trees and small groups of larger trees would burn, resulting in openings in the forest. Sunlight loving ponderosa pine and western larch seedlings would regenerate in newly created forest openings forming a new age class of younger trees, contributing to an overall mosaic forest structure.

In the absence of periodic fire, young trees, grasses, and shrubs proliferate in the forest understory. Organic material tends to accumulate on the forest floor due to slow rates of decomposition. Young trees encroach upon rangelands and forest openings, thereby reducing the capacity of these lands to provide forage for livestock and wildlife. As forest density increases, individual trees become increasingly stressed and tree growth rates decrease, due to increased inter-tree competition for light, water, and nutrients. Stressed trees have less natural resistance to insects, diseases and drought.

Soil moisture requirements, seed bed requirements, frost tolerance and the ability of a particular tree species to grow in shade (shade tolerance) are important factors that determine which tree species regenerate in forest and rangeland areas in the absence of wildlfire. Douglas-fir tends to increase in abundance where moisture is adequate and where some shade is present. These conditions are common on north and east aspects and in partially harvested forest areas. Ponderosa pine tends to reproduce successfully on southerly and westerly aspects, at lower elevations, and in full sunlight. Reproduction is most successful where seed falls on bare mineral soil and sunlight is abundant.

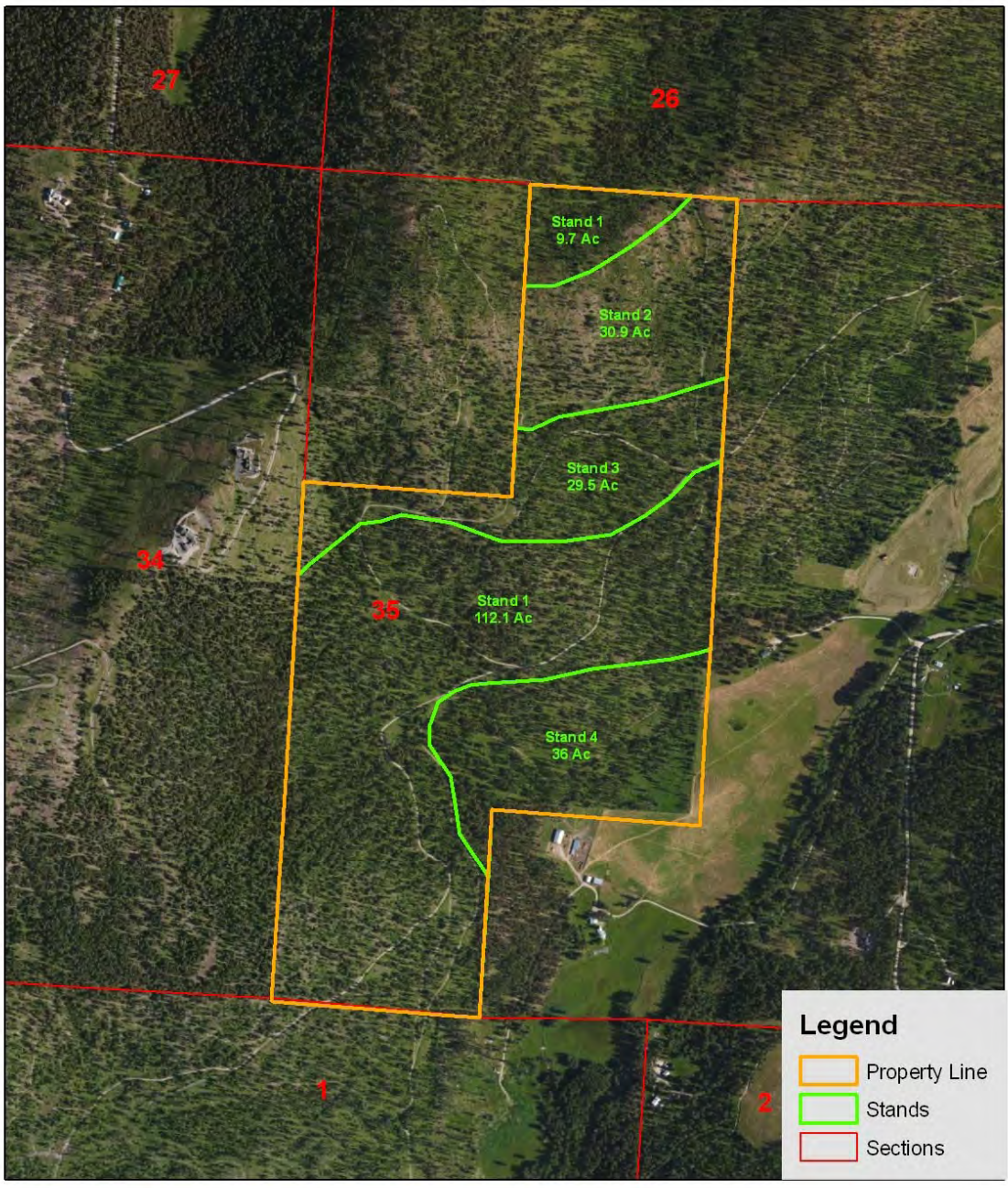
A shift in forest structure can have several negative aspects. One is increased risk of a high-intensity wildfire due to more fuel in general and especially ladder fuels. Ladder fuels (vertical layers of vegetation) allow fire to leave the ground and climb into the forest canopy, killing parts or all of the tall over-story trees. A second is that increasingly dense forest stand conditions stress individual trees decreasing growth rates and creating favorable conditions for insect and disease outbreaks.

Forest Stand Type Identification and Classification

Forest stand types were delineated for management planning and timber volume estimate purposes. Four distinct stand types were indentified on the property. Forest stand attributes considered are; tree species composition, tree-stocking rates by size class and merchantable timber volume. An analysis of individual forest stand attributes was completed to develop forest management alternatives for each forest stand type. Size class descriptions include seedling, sapling, pole, small sawtimber, medium sawtimber and large sawtimber. For purposes of forest stand classification, seedlings are defined as trees between 1 and 4.5 feet in height. Saplings are trees greater than 4.5 feet in height and less than 4 inches in diameter. Poles are trees with a diameter at breast height (DBH) of 4 to 6 inches. Small sawlogs are 7 to 10 inches DBH. Medium sawlogs are 11 to 14 inches DBH. Large sawlogs exceed 14 inches DBH.

Forest Stand Map

Foy's Community Forest Property
T28N, R22W PMM
Flathead County, Montana



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Forest Stand Descriptions and Management Recommendations

Stand 1

Stand 1 Description – Mixed Conifer (*predominately WL, PP, and DF*), Sawlog Stand, Moderately Stocked (3-5 MBF per Acre), Moderately Stocked Sapling (500-700 seedling/saplings per acre)

Stand 1 Sample Tree Descriptions –

East Line Sample Tree: 16" DBH WL, 74' tall, 160 years old. Zero to 50 years growth averages 10 rings per inch. Last 100 years rings are much tighter, averaging 35 rings per inch.

West Line Sample Tree: 14" DBH DF, 70' tall, 115 years old. Majority of growth has occurred since age seventy.

Stand 1 Total Acreage – approximately 122 acres

Stand 1 Estimated Total Merchantable Timber Volume – 487 MBF

Looking north into portion of Stand 1 from the Foys to Blacktail Trail. Western larch overstory is dominant in this photo. Douglas-fir regeneration is dominant in the understory.

Stand Description and Management Recommendations

This stand type is widely distributed across the ownership. The stand type is moderately stocked with sawlog-sized trees and generally includes a component of pole-sized (pulpwood) trees. The stand type includes sufficient sawlog and pulpwood volume to support economically viable timber harvesting operations in the future. Topography is generally moderate with slopes averaging from 20-40%. This stand tends to have seedling and sapling regeneration where forest openings are present.

An uneven-aged management approach is recommended to maintain the presence of a multi-layered forest structure. This will help protect scenic values and wildlife cover while reducing fire hazard. This approach would retain large diameter trees in good condition as well as healthy trees in smaller size classes. Some large diameter trees in poor condition or with broken tops would be retained as snag recruits.

Looking south through Stand 1. Plentiful natural regeneration exists with Douglas-fir currently dominating.

Advanced tree regeneration is present in the forest understory. This stand type has moderately abundant seedling and sapling regeneration. Management of the seedling/sapling size class should receive emphasis to encourage forest productivity. Natural regeneration is skewed towards Douglas-fir. Ponderosa pine and western larch are well-represented. Tree distribution is often clumpy.

Sapling-sized trees can be thinned to reduce competition between trees. Target spacing for retention trees is 12-15 feet, resulting in a stocking rate of approximately 200-300 trees per acre. Retention trees should be disease free, have straight stems, and a crown ratio of greater than 35%.

Slash disposal associated with pre-commercial thinning may include lopping and scattering limbs to within 2' of the ground where slash accumulations are light. Hand piling and burning of slash accumulations is recommended on slopes greater than 40%. Mechanical slash piling is likely to be cost effective on slopes less than 20%. Mechanical thinning and slash grinding may be economical on slopes of less than 30%. Retention of small dense thickets, ranging from ¼ to 5 acres in size is encouraged to provide hiding and thermal cover for wildlife. Avoid burning or grinding large diameter (greater than 12" diameter) down logs.

Healthy pole and sawlog-sized trees should be retained to provide forest structure and wildlife habitat. Large diameter trees (greater than 12" diameter) with broken tops or significant stem decay should be retained as snag recruits and for wildlife habitat. Retention of these trees is especially significant near riparian and wetland areas. All aspen trees should be retained and surrounding conifers thinned to stimulate aspen growth.

The north section of Stand 1 (~10 acres) is excellent wildlife habitat, especially as winter range for Whitetails. It is recommended that this north facing bowl have limited recreation access and be managed primarily as wildlife habitat.

Stand 2

Stand 2 Type Description – Mixed Conifer (*predominately PP and DF*), Small Sawlog Stand, Low Stocking (< 2 MBF per acre), Seedling/Sapling, Low Stocking (200 trees per acre)

Stand 2 Total Acreage – approximately 31 acres

Stand 2 Estimated Total Merchantable Timber Volume – 31 MBF

Stand Description and Management Recommendations

This stand is located in the northern portion of the property and includes primarily southeastern aspects. This stand type generally includes the least productive ground on the property. The stand includes both ponderosa pine and Douglas-fir in the overstory. Topography is generally moderately steep with slopes ranging from 10-50%.

Looking at the planted ponderosa pine on the ridgetop in Stand 2. Scattered Douglas-fir overstory is present.

Preferred species to retain on the site in order of preference are; ponderosa pine, western larch, and Douglas-fir. The previous harvests have removed the majority of the volume and the majority of the merchantable Douglas-fir. The remaining Douglas-fir is moderately to heavily infected with dwarf mistletoe and is of questionable value as sawlogs. The ponderosa pine overstory is widely spaced and is in good health. Tree planting has occurred in the past five to eleven years over the majority of the stand. One area planted approximately ten years ago near the north property line is doing extremely well. Throughout the remainder of the stand the planted ponderosa pine is doing well.

The emphasis in this stand type is to shift species composition towards ponderosa pine and space vigorous trees in a manner that improves tree growth and reduces wildfire potential. The stand type is best suited to even-aged management and the goal in this stand type in terms of timber production is to grow a stand of sawlog-sized trees in the shortest time period possible. Thinnings are intended to maintain or increase diameter growth of retention trees. Retention trees should have a dominant position in the forest canopy, straight form and tree crown ratio of 30% or greater. Spacing between trees in some areas can be clumped and uneven, leaving small forest openings as well as groups of more tightly spaced trees for wildlife hiding and thermal cover.

Slash disposal associated with pre-commercial thinning may include lopping and scattering limbs to within 2 feet of the ground where slash accumulations are light. Hand piling and burning of slash accumulations is recommended on slopes greater than 45%. Mechanical slash piling is likely to be cost effective on slopes less than 20% but opportunities may be limited due to tighter tree spacing which limits the ability of machinery to move between trees without causing damage. Mechanical thinning and slash grinding may be economical on slopes of less than 40%. Retention of small dense thickets, ranging from ¼ to 5 acres in size is encouraged near stream courses, wetlands, benches and ridgetops to provide hiding and thermal cover for wildlife. Avoid burning or grinding large diameter (greater than 12" diameter) down logs. If clearcutting is determined to be the optimal forest treatment slash would likely be broadcast burned or mechanically pile with an excavator or bulldozer with brush blade.

Stand 3

Stand 3 Type Description – Mixed Conifer (PP, DF, WL), Small Sawlog Stand, Moderately Stocked (less than 3.0 MBF per acre)

Stand 3 Sample Tree Description

7" DBH PP, 33' tall, 80 years old. 30 years growth to one inch DBH. Next forty years to grow from 1" to 4". Last 12 years tree grew from 4" to 7".

Stand 3 Total Acreage – approximately 29 acres

Stand 3 Estimated Total Merchantable Timber Volume –
58 MBF

Stand Description and Management Recommendations

This stand is present on the north central portion of the property. Topography is slight to moderately sloped with slope grade ranging from 10-30%. The stand was commercially thinned and has a healthy component of pole and small sawlog-sized trees that have been released and are in good condition. No further treatment is required in the pole or sawlog class for the next decade.

Uneven-aged management is encouraged to maintain presence of several different size and age classes. There are dense thickets of sapling-sized trees require thinning to reduce the fire hazard and competition between trees. These thickets are primarily Douglas-fir and are scattered, but are very dense.

Representative condition in Stand 3 - Ponderosa pine overstory with overstocked thickets of Douglas-fir regeneration. Most of the thickets should be thinned for forest health, while some should be left for hiding cover and future thermal cover for wildlife.

Retaining defective large diameter trees will provide future snags that can be utilized by a variety of wildlife species. All healthy larger diameter ponderosa pine should be retained where possible.

Merchantable tree volume averages less than 3.0 MBF per acre. However, this stand has potential to generate significant merchantable timber volume over the next several decades.

Stand 4

Stand 4 Type Description – Mixed Conifer (PP, DF, WL), Sawlog Stand, Moderately Stocked (5-7 MBF per acre), Seedling/Sapling, Low Stocking (100 trees per acre)

Stand 4 Total Acreage – approximately 36 acres

Stand 4 Estimated Total Merchantable Timber Volume – 180 MBF

Stand Description and Management Recommendations

This stand is located in the southeast portion of the property. Topography is slightly sloped with slopes ranging from flat to 20%. The stand was commercially thinned and has a healthy component of sawlog-sized trees that have been released and are in good condition. No further treatment is required in the sawlog class for at least the next decade. Healthy larger diameter ponderosa pine and western larch are preferred retention trees. Retaining defective large diameter trees will provide future snags that can be utilized by a variety of wildlife species. Uneven-aged management is encouraged to maintain the presence of several different size and age classes.

Representative condition of Stand 4 - Healthy western larch & ponderosa pine are present in the overstory. Healthy but slightly understocked regeneration is present in the understory.

Merchantable tree volume averages approximately 5.0 MBF per acre. This stand has potential to generate additional merchantable timber volume over the next several decades.

Foy's Community Forest Total Sawlog Volume Estimate

The timber volume estimates provided in this plan are based upon visual observations made in the field during the stand delineation process. The estimates were made by an experienced professional forester employed by Northwest Management, Inc. The estimates were made based on previous experience with timber harvest yields in similar forest types. These timber volumes estimates are intended only for the purposes of stewardship planning and the development of stand type silvicultural recommendations. Timber volumes estimates in this document are not sufficient for determination of annual forest yield or timber valuation and appraisal purposes. *A statistically sound forest inventory is required to determine timber volume, timber value and timber growth and yield estimates.*

The total sawlog volume estimate (Stands 1-4 combined) for Foy's Community Forest is 756 MBF (Thousand Board Feet).

Silvicultural Approaches to Forest Management

Purpose and Scope

Several of the management goals for this property can be achieved by the implementation of recommended silvicultural practices. This section provides a general discussion of the process of forest succession and both even and uneven-aged silvicultural approaches to forest management. Potential limitations associated with various silvicultural approaches are also described.

Understanding Forest Succession

Succession is the process where one plant community is replaced with another until the plant community is in equilibrium with the soil development. When the plant community is in equilibrium with soil development, the plant community is said to be at climax. A climax plant community may perpetuate itself until a natural or human caused disturbance alters the forest environment creating conditions favorable to the establishment of a different plant community. With or without human influence forest plant communities change over time. Forest managers seek to understand how environmental conditions influence the forest environment in order to encourage the development of forest plant communities that will achieve stated management objectives.

Disturbance of the climax plant community may occur due to events such as wildfire, timber harvest, disease, insect infestations, or damaging winds. These disturbances initiate the process of secondary succession. Secondary succession continues until the plant community reaches equilibrium again with the soil development and the vegetation is at climax. Secondary succession begins with the establishment of seral tree species and invader grasses, forbs and shrubs. Over time, the climax species replace the seral species as the forest environment becomes more favorable for the climax species.

Shade intolerant trees, shrubs, forbs and grasses will often colonize recently disturbed forest sites. Shade intolerant tree species present on the subject property include ponderosa pine and western larch. These species will naturally reproduce in forest openings, such as recently harvested areas, where the forest overstory has been removed. Shade tolerant plant species increase in abundance once a forest canopy develops and the forest understory becomes partial shaded. Sunlight loving forbs, shrubs and grasses often decrease in abundance in a shaded forest environment. Shade tolerant tree species such as Douglas-fir, grand fir, and subalpine fir tend to increase in abundance on cooler aspects and in partially cut areas and undisturbed forest stands. The environmental conditions existing within each stand will drive the process of succession and influence the composition of the forest plant community.

Forest management regimes should not necessarily encourage development of climax plant communities. The seral tree species associated with secondary the plant community often have a higher rate of production (growth) than the climax tree species. Climax trees species are generally less tolerant of drought and fire and more vulnerable to stem decay and root disease. For these reasons, managing for the seral tree species is generally desirable in areas where timber production is a priority. However, the structure and species composition of climax forest plant communities provide unique and valuable habitats for many wildlife species. Development of climax forest communities is encouraged where wildlife habitat goals receive management emphasis. These areas often include riparian corridors, valley bottoms and wetland areas.

Uneven-Aged Management

Natural plant communities develop through known successional pathways and are often altered through disturbances. Major disturbances, such as catastrophic wildfire or timber harvest (clear cutting) are often severe enough to set a forest plant community back to the beginning of succession. Less severe and more common disturbances, such as insect or disease infestation

may affect only a single tree or a small group of trees, altering succession to a lesser degree. This process is often referred to as “Gap Succession”.

Gap succession creates small openings in the forest canopy that provide space for a new age class of young trees to develop. This process increases complexity in forest stands by creating conditions that favor multiple tree species and multi-layered forest structures.

Ecologically, uneven-aged silviculture reflects a land manager’s effort to imitate naturally occurring patterns of plant succession and natural forest disturbance. The advantages of uneven-aged silviculture are that the stand’s structure, productivity, and cover are maintained over time. Ponderosa pine types are often well suited to uneven-aged management because harvesting can simulate a stand structure similar to the types that develop as a result of frequent, low intensity wildfires.

Opportunities to simulate stand structures resulting from mountain pine beetle, western pine beetle and Douglas-fir beetle attacks exist in the ponderosa pine and Douglas-fir stands which include a component of mature trees.

Group selection harvesting is used to approximate intensive small-scale disturbances that create larger openings within a stand. Natural examples include localized insect infestation, windthrow, or flare-up of a surface fire.

Single tree selection harvesting mimics the smallest scale of succession such as when a single tree falls or dies. Causes of mortality may include lightning, disease, insects, and windthrow. In small gaps, the opening in the forest canopy may fill before regeneration can fully develop. This regeneration in the forest understory may stagnate and persist with little growth and will eventually become suppressed and die.

Gap size in the forest canopy is a critical link to successful regeneration of desirable tree species. Larger gaps favor species intolerant of shade such as ponderosa pine. Harvest unit layout varies opening size, shape, density and orientation to provide more natural landscape patterns in the forest. After treatment, residual basal areas of 40-60 square feet per acre will encourage conifer regeneration and limit vulnerability to insect and disease pests associated with stress. Trees left after harvest must be of sufficient size and maturity to be reliable seed bearers. Marking of leave trees in harvest units is often recommended to ensure multiple age classes, variable tree sizes, and healthy seed trees are well-represented in treated stands.

<u>Limitations</u>

Steep slopes (greater than 40%) are a special challenge given the potential for mechanical damage to the residual stand during repeated harvest entries. Stands where canopy layers are stratified with intolerant species in the overstory and tolerant species in the understory require intensive management to ensure adequate regeneration of shade intolerant species. Dense, uneven-aged forest structures dominated by a single tree species can be vulnerable to western spruce budworm and dwarf mistletoe. Multiple stand entries in conifer stands where root disease is present can create conditions favorable for the spread of disease.

Even-Aged Forest Management

Montana's forest areas are subjected to many different fire regimes as the result of the climate, topography and vegetation. The fire regime is specific to each area in regards to frequency, size and severity. Even-aged management is often recommended for forest types that experience mixed to high severity fires. These regimes are most common at higher elevations where fires are less frequent and fuels build up over time. High elevation lodgepole pine/subalpine fir forests in the Rocky Mountains experience stand replacing fires at intervals of 75–300 years. These fires are less frequent but are often more severe, resulting in complete or nearly complete mortality in the stand. The outcome is the development of even-aged stands spread out in a mosaic pattern across the landscape.

An even-aged harvest prescription is often recommended to establish natural regeneration of shade intolerant species such as lodgepole pine, ponderosa pine and western larch. Even-aged harvest methods may also be recommended to control insect and disease outbreaks, manage suppressed stands comprised of predominately low vigor trees, create diversity in otherwise homogenous forest landscapes, and treat stands on moderately steep slopes which are prone to damage from multiple harvest entries. The method can also be used to salvage merchantable timber following a wildfire.

An even-aged silvicultural system is a planned sequence of treatments designed to maintain and regenerate a stand with one age class. Once tree regeneration is well established, intermediate treatments like tree thinning may be used to control stand stocking and species composition several times over the length of the rotation. Thinning is intended to stimulate the growth and vigor of trees by reducing the competition for light, water and nutrients. Thinning is most beneficial in young vigorous stands but may be used in areas with trees that have reached merchantable size.

The rotation length is the period of years required to grow a crop of timber to specified condition of economic or biologic maturity. There are three regeneration harvest methods used in even-aged systems: clear-cut, shelterwood and seed tree harvests. These methods vary by the residual stand left after harvesting and the purpose of these residual trees. Each method is designed to regenerate a new stand of shade intolerant tree species.

Clearcuts are a method of regenerating an even-aged stand in which a new age class develops in a fully exposed micro-environment after removal of all trees in the previous stand in a single cutting. Regeneration can be from natural seeding, direct seeding, planted seedlings and/or advance reproduction.

For a shelterwood harvest prescription, one or more cuttings are made to begin the development of a new age class before the old stand is completely removed. Partial shade from the residual overstory provides protection to newly developing seedlings. This method is commonly used to encourage regeneration of Douglas-fir and ponderosa pine on drier sites and south aspects.

A seed-tree harvest is an even-age management system where only a few widely-spaced residual trees are maintained on site as seed sources. The seed-tree method is very similar to the shelterwood method, differing only in the amount of residual stocking left during harvest and the

purpose of the residual overstory trees. In the seed-tree method, fewer trees are left on site and these residual trees serve only as a seed source (seed-trees). Foresters normally use the seed-tree method with light-seeded, wind-disseminated, shade-intolerant species such as western larch.

The choice of even-aged regeneration method will depend on both landowner objectives and the forest type under management. Clearcutting is often less costly than other methods due to fewer stand entries and is therefore the most often preferred method for appropriate species, such as lodgepole pine.

Limitations

Clearcuts produce the most drastic changes to microclimate, wildlife habitat and aesthetics, and therefore may not be an attractive choice for areas where non-timber forest commodities are emphasized. If not properly planned, clearcuts can increase erosion, landslide and rapid runoff of water. The risk of this type of damage is greatest on steep slopes. Avoiding the use of clearcuts on erosive soils and utilizing appropriate harvest technologies such as cable and mechanical cut-to-length harvesting will protect soils and mitigate potential negative impacts. Historically, foresters have used shelterwood and seed-tree methods to provide alternatives to clearcutting. Most even-aged regeneration systems rely on natural regeneration, but in some cases artificial regeneration (planting or direct seeding) is used as a primary or supplemental source of regeneration.

Description of Recommended Forest Management Practices

Tree Thinning

Cutting of trees in an immature stand for the purpose of stimulating the growth and vigor of residual trees is known as tree thinning. Trees cut in a *pre-commercial thinning* have no commercial value and normally none of the felled trees are removed for utilization. Trees cut in a *commercial thinning* have commercial value and are harvested for utilization as a wood product. The primary objective of both types of tree thinning is to increase the total yield of merchantable wood products produced from a forest stand. Tree thinning operations are implemented to regulate tree-stocking rates in a manner that optimizes production of merchantable trees. The principles and benefits associated with tree thinning apply to both even and uneven-aged stands. Thinning is the primary means by which the productivity of overstocked forest stands can be improved.

The advantages of tree thinning are less pronounced in stands comprised of mature trees. The sudden exposure of trees in dense stands can make them vulnerable to windthrow. Trees in dense stands may have poorly developed root systems. Shallow rooted species such as lodgepole pine and Engelmann spruce are especially vulnerable to windthrow in heavily thinned areas.

Tree thinning can be used to accomplish management objectives other than production of merchantable timber. Thinning can increase water yield from watersheds, enhance the development of forest understory vegetation for wildlife or livestock, improve aesthetics of forest stands, and reduce fire hazard.

A good thinning program will meet one or more of six objectives:

1) To use or sell trees that would otherwise die naturally and eventually decay;
2) To redistribute the total fiber growth of the stand to fewer trees of higher quality, thereby increasing the value of usable fiber;

3) To provide money to pay off investments, such as reforestation, pre-commercial thinning, and other stand improvement activities;
4) To enhance non-timber resources like wildlife, water quality, recreation, aesthetics, and grazing;
5) To provide more frequent income opportunities;
6) Reduce fire hazard.

Tree Selection Guidelines

Trees in a forest stand compete for growing space in the forest canopy and in the soil. Trees in dense stands struggle for existence and have reduced growth and vigor. Reducing the number of trees per acre by removal of less desirable trees allocates light, water and nutrient resources to the most vigorous trees on a site. Vigorous trees tend to occupy superior positions in the forest canopy and have more fully developed crowns. The position of a tree's crown in the forest canopy is an important criterion when deciding whether it should be cut or retained. Reducing competition for space in the tree canopy is significant since the tree's foliage produces the energy on which the tree depends. Retention of vigorous dominant and co-dominate trees that have not developed coarse branches is generally recommended because these trees have crowns that receive sunlight from above and/or from the side. Coarse branches are viewed as an undesirable tree attribute for crop trees because they may lower the quality of log produced from the tree. The selection of trees to be favored and of those to be cut is based not only on the relative position and condition of the crown, but also on the health of the tree, genetic attributes of the tree, and condition and quality of the tree bole. Removal of genetically inferior trees will improve the genetics in a forest over time. Undesirable tree species can be targeted for removal from stands during thinning operations and the composition of species within a stand can be controlled to meet various forest management objectives.

Reductions in stand density accomplished by thinning usually encourage faster tree diameter growth and increase the proportion of stem wood large enough for profitable use over time. It may take a period of several decades following a thinning for the stand to reach full occupancy of the site. The beneficial effects of thinning are especially significant in areas where soil moisture is limited during the growing season.

A good criterion to determine when to apply a commercial thinning is by evaluating the average live crown ratio of potential crop trees. If the live crown ratios of crop trees fall below 35-45%, thinning may be required to prevent a reduction in growth rate and tree vigor. Another effective way to determine when thinning is required, is to look at how the branches relate to each other from adjacent trees. If the branches from one tree overlap the branches of the other trees, then those trees are competing with each other.

Pre-commercial thinning is especially important in very dense stands of natural reproduction. These stands are likely to stagnate without early intervention. The ability of trees to improve their growth rates (release) decreases as tree age increases. Every effort should be made to thin dense stands of young trees at a young age (10-25 years). Typically, thinning can occur once differentiation of crown classes or inter-tree competition is evident.

Basal Area

Basal area is a measure of stand density expressed as square feet per acre of tree stem cross sections measured at a point 4.5 feet from the ground. Basal area per acre is easily measured with a timber cruise or field inventory. Basal area targets can be developed for stands that are predominately comprised of merchantable-sized trees. Once a stand approaches a recommended upper limit of basal area per acre it can be evaluated to determine if a reduction in basal area is required. Where appropriate, the basal area of the stand is reduced to a pre-designated lower basal area per acre limitand then allowed to grow over time to the upper limit or threshold value again.

The range of optimum tree stocking rates and basal area will vary by site, stand age, size class, distribution and species composition of a particular forest stand. Forest management objectives will also deterimine appropriate stand stocking levels. For example the stand may be kept at a basal area density higher than the recommended optimimum for tree growth to provide hiding or thermal cover for deer and elk. Generally poor sites will have a lower optimum tree-stocking rate than moderate to good sites for tree growth..

Altering Species Composition

Species composition of a forest stand is controlled when desirable tree species in good health are retained and less desirable species removed during thinning and harvesting operations. Desirable tree species are those best adapted to the growing conditions on the site and most capable of utilizing available resources to produce merchantable-sized trees in the shortest period of time. Determination of which tree species are most desirable on a given site depends on several variables. These variables include insect and disease resistance, fire resistance, drought tolerance, shade tolerance, soils, aesthetics and local markets for wood products. Where saw-timber production is the primary objective, the focus of tree thinning is to ensure that crop trees develop vigorous crowns and straight stems with smaller braches.

Various methods of thinning are used to accomplish different management objectives. The type of thinning selected will depend on age, size, condition and species composition of the forest stand. Late summer and fall are generally the best time to implement tree thinning. Trees are less susceptible to bark damage at this time, and slash generated from the thinning has less potential to attract bark beetles.

Common Tree Thinning Methods

Low thinning – his method employs a thinning method where the shorter trees are removed while taller dominant trees are not cut; thus, salvaging trees that ultimately will die. Reduction in crown competition between dominant and co-dominant trees is not significant since most of these trees are retained. Root competition for nutrients is reduced. Fire hazard is reduced by removal of ladder fuels from the forest understory.

Crown thinning – Trees from lower crown classes and co-dominate trees in poor to fair condition are cut. Some dominant trees in poor condition may be cut to favor healthy co-dominants. There is increased potential for harvest of merchantable-sized trees. Root competition for nutrients is reduced. Competition for growing space in forest canopy is reduced. Fire hazard is reduced by removal of ladder fuels in the forest understory and increased distance between tree crowns.

Selection thinning - Trees from all size classes are cut to release designated crop trees. The emphasis is on retention of healthy vigorous trees. Stocking rates may vary across the stand depending on age class and distribution of healthy trees. This method is generally suited to stands that have multiple age and size classes and varied species composition. Selection thinning is often recommended as the initial treatment in previously untreated natural stands. It is also recommended to maintain or further develop uneven-age stands. Selection thinning in an unevenly stocked stand might remove scattered undesirable dominant trees and co-dominant trees which are crowded or in poor to fair condition, and include low thinning to salvage or remove overtopped and intermediate sized trees. Clumps of regeneration may be thinned based on spacing guidelines to achieve preferred stocking rates. The development of individual crop trees guides decision-making. Attention is directed at releasing potential crop trees of various size classes.

Tree Pruning

Pruning the lower limbs off a tree encourages the production of higher value knot free wood, called clear wood. It is an investment in the individual tree and the future high quality wood. Pruning also reduces the chances of a ground fire reaching the canopy of the individual tree or adjacent trees by using ladder fuels; the lower limbs of trees that are close to the ground or shrubs which may act as a ladder from the ground to the top of the tree.

Pruning for high quality wood is most cost effective in young healthy forest stands. Young trees heal their wounds faster than older trees. Pruning when branches are small reduces knot size. Young trees have more time to grow clear wood thus increasing their potential value. Young trees are easier to prune and thus less expensive to prune. It is important to never remove more than 50% of a tree's live crown. For example, if you have a small tree that is twenty feet tall and has green limbs top to bottom then you can prune the lower ten feet without impacting the tree's health.

If a tree is twenty feet tall and has green limbs from the top down to six feet off of the ground (14 feet of live crown) then you can remove seven feet of live crown, which would give you a pruning height of thirteen feet (6 feet of dead branches plus 7 feet of pruning green limbs).

Monitoring

Periodic evaluation of forest condition is important. The goal is to catch problems while they are small and easy to remedy. In addition to the health of the forest, foresters and landowners should evaluate condition of understory vegetation (weed infestations) and capital improvements such as roads, bridges, culverts, and fences. It is also important to review the management goals for the ownership. Landowner situations change, as does the forest itself.

Fish and Wildlife Habitat

Fish and Wildlife Habitat Introduction

All forest-dependent wildlife require food, water, shelter from inclement weather (both summer and winter), and cover from predators for breeding, rearing of young, and feeding. The mixture of forest vegetation types and landforms determines suitability of habitat for each particular wildlife species. A diverse mixture of tree and shrub species, sizes, and age classes, as well as dead and dying trees in the form of snags and coarse woody debris (fallen trees and large logging debris) will increase wildlife species diversity and abundance. The presence of water and

associated vegetation (riparian/wetland areas) in proximity to diverse forest habitats enhances biological diversity.

The property is currently used by a wide assortment of wildlife species. White-tailed deer, elk, mountain lion, and black bear are a few of the major big game species that can be observed on the ownership. Many of these species use portions of the property on a year-round basis. Other mammals that likely utilize habitats on the property include coyote, deer mouse, porcupine, raccoon, pine squirrel and numerous song birds.

Each wildlife species has a set of specialized requirements, including food, water and cover. If one of these requirements is in short supply, the overall effectiveness of the habitat is reduced. The requirement that is in short supply is referred to as a limiting factor. Cover, food and water requirements can be further broken down into sub-factors.

Wildlife habitat can be protected, enhanced, and even created with appropriate management done in conjunction with other forest management activities. A brief explanation of some of the important wildlife habitat components follows along with management recommendations.

Important Forested Wildlife Habitat Components

Snags and Coarse Woody Debris

About one-third of forest wildlife species are dependent on snag (standing dead trees) and coarse woody debris (down logs and trees). More than 60 of these species use cavities (holes excavated in trees) created primarily by woodpeckers for denning, nesting, and shelter. Most cavity nesters prefer the harder and larger diameter snags; those that are in the earlier stages of decay. The taller and larger diameter snags benefit more species, for a longer period of time, than the smaller snags. However, small diameter and shorter snags (including stumps at least 3 feet in height) are also utilized for feeding and cover. Snag dependent wildlife also use live trees with substantial amounts of decay. This includes broken tops, large dead and/or broken branches, cracked or damaged boles, heart rot, and mistletoe and rust brooms. Brooms (clumps of deformed branches) caused by these pathogens are readily used by platform nesters such as hawks, owls, eagles, and ospreys and as shelter for mammals such as squirrels and pine martens. Most wildlife species that use snags will use trees with substantial decay. Many of these defective trees will last for long periods of time and although they have little economic value, they have excellent value to snag-dependent wildlife.

Coarse woody debris (large diameter downed trees) goes through a similar decay cycle and use pattern as snags. The larger diameter and longer length hard logs last longer and are used by more wildlife species than the smaller and softer pieces of coarse woody debris. Ideally, these two components should be scattered throughout forested stands. Large diameter snags and coarse woody debris are scarce in managed forest stands. Management practices that retain dead and dying large diameter trees are encouraged, especially near riparian and wetland areas.

Understory Vegetation

Grasses, forbs and shrubs increase in abundance where sufficient soil moisture and sunlight are present. These conditions are present in natural forest openings or where management activities such as timber harvesting and pre-commercial thinning have created openings in the forest

canopy. Numerous bird species utilize understory vegetation for nesting, foraging and cover. Maintenance of tall shrubs and grasses in forest stands and near riparian areas will improve bird habitat. Mammals use this habitat feature for food, shelter, and cover. Grasses and forbs provide cover and food for small mammals such as mice and voles. Bunchgrasses, many forb species and several shrub species are preferred forage for elk and deer. Tall shrubs such as alder, buffaloberry, willow, serviceberry, and black hawthorn provide valuable wildlife habitat and should be retained where possible by maintaining the forest openings in which they tend to be located. Understory vegetation will tend to decrease in abundance where the forest canopy cover exceeds 40%.

Cover

High plant diversity across a landscape meets many of the cover requirements for different wildlife species. Cover requirements also differ within a species depending on time of year and the activities of the animal. Cover can be broken down into sub-components of thermal and security cover. These differ in their functions but may occupy the same area.

The vegetation that provides thermal cover is generally denser than security cover. Thermal cover gives animals protection from the elements by providing them with warmer conditions in winter and cooler conditions in summer. Thermal cover requirements vary with species, ranging from conifer thickets for deer and elk to the grass cover used by smaller mammals such as mice and voles.

Security cover provides animals protection from predators and hunters. Uses include resting, loafing and bedding, feeding, travel corridors and areas for rearing young. The most effective habitat includes components of both thermal and security cover in proximity to the other main habitat components of food and water. Interspersion of the important components increases an animal's ability to travel between and use the various areas.

Food

High plant diversity also offers a broad variety of foods needed by different species. Deer, moose and elk vary in their food choices. White-tailed deer commonly browse the tips of woody trees and shrubs and will forage on broad-leaved forbs when they are available. Elk graze on herbaceous plants such as grasses, clover and alfalfa, feeding on browse when it is readily available. Moose are primarily browsers, preferring the tips of woody trees and shrubs, especially willows and red-osier dogwood. They will also consume a variety of broad-leaved forbs depending on availability.

Most bird species present in the local areas feed primarily on fruits and seeds, insects and nectar. A diverse plant base that meets all these components will ensure a diverse bird population.

Water

The need for water varies between species, ranging from the strong association and absolute water requirement of amphibians and aquatic mammals to species that require only minimal amounts for drinking water. Waterfowl, including migratory ducks and geese, use open water for escape areas from predators and also feed on aquatic insects, crustaceans and plants. Shorebirds, such as snipe and herons, use shallow water areas for feeding and will nest along the shorelines.

As stated earlier, the addition of wetlands and the enhancement of riparian conditions will increase wildlife abundance and improve the potential for increased wildlife diversity.

Wildlife Habitat Management Recommendations

Create and Maintain Forest Openings

Creating forest openings improve wildlife habitat for many wildlife species. Dense forest canopies (greater than 60% cover) provide deep shade, catch and divert rainwater, intercept snow and deposit branch and leaf litter on the forest floor, acidifying soils. These factors inhibit grass, forb and shrub production. Openings in the forest canopy provide growing conditions that favor grasses, forbs and shrubs due to an increase in available sunlight and available soil moisture. The partial shade found in forest openings tends to moderate temperatures and retains soil moisture. Grass, forb and shrub seed production is generally increased providing food for small mammals and birds. The edges created by the contrast between the forested area and a forest opening provide attractive habitat for a diverse array of wildlife species.

Small forest openings, of 1-3 acres in size, can be systematically created in dense forest areas during timber harvests. Retaining or creating structures such as downed logs or brush piles in the openings, will increase wildlife use. During thinning operations consider a variable density-thinning pattern to mimic natural patterns of disturbance. This involves applying an uneven spacing between trees as well as retention of different tree sizes and species. Some patches (at least 50 feet in diameter) should be thinned heavily to favor development of shrubs and ground cover and some patches (also at least 50 feet in diameter) should be thinned very lightly or not at all to retain shelter and cover for those species using this layer of forest vegetation. These variable density units should be scattered throughout the landscape. Existing snags that do not pose safety problems should be retained to the extent possible.

Maintain Deciduous Shrubs and Trees

Thickets of deciduous shrubs and trees provide excellent winter cover for a variety of mammals and birds. Deer and elk depend on deciduous shrubs as primary browse forage over much of their range. Because they are highly preferred by deer, bear and elk, biologists often call deciduous shrubs and trees, such as quaking aspen, red-osier dogwood, willow and chokecherry, “ice cream plants”. During late winter, grouse will heavily consume buds of aspen and use the aspen stands for thermal cover.

The property has snowberry and serviceberry present in all stands. Ninebark is present in most stands, but is dominant in Stand 3. There are other minor shrubs present in some of the stands. The serviceberry has the the biggest benefit for birds and mammals residing on the property and should be maintained.

Maintain Snags

Maintenance of snags (dead, standing trees) will increase the use of the forested portion of the property by a number of wildlife species. These species tend to use the snags for nesting, denning, perching, roosting, resting and feeding. Many wildlife species associated with snags perform beneficial functions. For instance, bats and tree swallows, both cavity nesters, are important consumers of insects, including mosquitoes. Woodpeckers, who use snags for nesting and foraging, consume many insects known to be harmful to trees. Kestrels hunt in open fields,

capturing insects and small rodents. Several owl species also use cavities for nesting and hunting. When possible, existing snags should be retained within timber harvest areas. Tree species selected for snag retention in order of preference are:

1. Ponderosa pine
2. Douglas-fir
3. Western Larch
4. Aspen
5. Lodgepole pine

Thomas (1979) recommends a rate of 2.25 snags per acre (most management practices require 3 or more per acre) to meet habitat requirements of 100% maximum potential population level of cavity nesters. One snag per acre will meet requirements for a 40% population level. Snag replacements should be as large in diameter and height and possible. Thomas suggests that a range of diameters is desirable, with a minimum size of ten inches diameter at breast height (DBH) and 93% of all snag replacements exceeding twelve inches DBH. At least 6% of all retained snags should exceed 20 inches DBH. A mix of species will diversify use and stagger retention time.

Recruitment snags (dead or dying trees), or those prime snag trees will be located and marked to ensure a consistent, long-term supply of snags on the property.

Snag on east side of property.

Timber Harvesting Guidelines for Snags

Retain as many snags and defective trees as possible in each stand for cavity and snag-dependent wildlife. Mark or identify trees to be retained prior to timber harvests; consider creating snags during harvest. Low value trees should be used for snag creation (but not existing "wildlife trees" that have existing substantial defect). Trees with low economic value that contain obvious defect should be retained wherever possible. Created snags can include size ranges from high stumps (at least 3 feet in height and at least 10 inches in diameter) up to those that are at least 16 inches in diameter and at least 30 feet tall. Snags can be created from conifers by girdling at the point of desired breakage, with a chainsaw, or with a mechanical harvester at time of tree harvest. Snags are a safety hazard and should be removed near buildings, trails, and heavy human use areas such as log landings.

Retain Downed Logs

In addition to snags, downed logs retained throughout the forest unit will increase wildlife use. Species present on the property likely to use the downed logs include squirrels, voles, reptiles and amphibians. The number of downed logs should be twice the suggested minimum for snags

and should follow the same basic guidelines for species, lengths and diameters as those listed above for snags.

Timber Harvesting Guidelines for Down Logs

Retain coarse woody debris if possible. Large treetops and butt ends that are bucked during harvest can be retained for coarse woody debris. This component can also be created from poor quality trees that are at least 20 feet long and at least 10 inches in diameter at the small end. When small amounts of blowdown occur between harvests, consider leaving a portion of the individual tree or large pieces of trees for wildlife. The large size pieces (>12 inches diameter) are best.

Create Drumming Logs

"Drumming" logs are downed logs regularly used by male ruffed grouse to drum for a mate and advertise his territory. Commonly, each male grouse will dominate eight to ten acres, to the exclusion of other males, with one hen per male. Grouse will often use drumming logs year after year. A drumming log can be constructed by placing the end of a large log, six to eight feet or longer, against the trunk of a small tree. A log, or even a pile of logs, that will place the grouse about afoot above ground level, and situated where a high number of saplings will develop around it, works best.

Forest Understory Management

- Retain understory vegetation wherever possible. Sites disturbed through harvest and management activities could be seeded to a wildlife forage seed mix.
- Planting shrub species such as black hawthorn, serviceberry, chokecherry, and buffaloberry can be undertaken to enhance species diversity and berry production. This would help all wildlife species, particularly birds. These shrubs species require adequate soil moisture and abundant sunlight.
- Planting hardwoods such as quaking aspen in draws and adjacent to riparian areas can improve aesthetics and future wildlife habitat, especially for grouse.
- Manage domestic livestock grazing carefully to protect the understory vegetation. Avoid over-use of riparian area vegetation especially in the spring during nesting season.
-

Elk and Whitetailed Deer Habitat Improvement

Recommended activities may include the following:

- Winter range
    - Eliminate or significantly reduce human disturbance in low elevation forests during winter months especially during periods of deep snowfall.
- Transitional range
    - Conduct fall prescribed burns in where desirable shrubs are present (serviceberry, Rocky Mountain Maple) to promote growth of young shoots.
    - Preserve and maintain forest stands of varying ages.
    - Close calving areas to human activity from May 15 to July 1. Preserve logs and other woody material on forest floor in calving areas to provide cover for newborn calves.
- Security cover
    - Conduct tree harvesting to maintain multiple age classes of forest cover.

Threatened and Endangered Species

Species of Special Concern

A Species of Special Concern Report (see Appendix) produced by the Montana Natural Heritage Program for Foy's Community Forest indicated that there are no known occurrences of federally threatened or endangered species located within the property boundaries. However, the wetlands along lower Birch Creek support one of two populations of Northern Leopard Frogs found in western Montana. It also supports a resident population of Western Toads. Both of these amphibians are identified as species in greatest need of conservation in Montana's fish & wildlife conservation strategy.

Forest Health

A healthy forest is:

1) Resilient to natural and human disturbance;
2) Biologically diverse;
3) Able to provide a sustained habitat for vegetation, wildlife, and humans.

Trees require adequate light, water and nutrients to maintain their health and grow to their biologic potential. If one or more of these elements are missing or insufficient, the tree experiences stress. Stressed trees are vulnerable to insect pests, disease problems and reduced growth rates.

The abundance of sunlight in the forest is managed by controlling the number, size and density of trees. The optimal amount of sunlight varies with individual tree species present and management goals for the property. For example, lodgepole pine, western larch and ponderosa pine require full sunlight to reproduce successfully. Douglas-fir is able to reproduce in partial shade.

Tree thinning is the primary method used to control forest density, species composition and tree growth. Pre-commercial thinning is applied in young forests before trees have commercial value. The objective is to cut less desirable trees and create additional growing space for the remaining trees. The trees cut can be left in the forest to decompose and recycle nutrients.

Commercial thinning is implemented when trees are larger, older and have commercial value. Cut trees are removed and sold to wood products manufacturers. Before tree thinning is implemented, a forester prepares a silvicultural prescription. The prescription details the goals of the thinning project and describes how, where, and when the work will be accomplished.

The intermountain west typically experiences dry summers. During this period trees depend on moisture stored in the soil to maintain their growth. Deeper soils and cooler aspects (north and east) benefit tree growth because they store greater amounts of water that is available later into the growing season. Where soils are shallow, or the aspect is hot and dry (south and west) tree growth slows during drought periods due to a lack of soil moisture. Shade-intolerant (light loving) species are adapted to grow on hot, sunny areas (south and west aspects) and are more resistant to drought. Shade-tolerant species grow in cool, moist forests found on north and east aspects and adjacent to riparian areas. Shade-tolerant species are less resistant to drought. Thinning reduces the total number of trees competing for water allowing residual trees to obtain

soil moisture for a longer period during the growing season. Forest productivity is often enhanced when dense (over-stocked) forests are thinned to reduce competition for soil water.

The availability of nutrients in the soil will influence the potential for tree growth. Nutrient availability is influenced by soil type and the abundance of organic material present in the soil.

The primary forest health problem in Montana is over-stocking (too many trees per acre). Over-stocking causes tree stress because neighboring trees must compete intensively for light, water, and nutrients. This is a problem on portions of the property where branches from adjacent trees touch or overlap each other. Leaving the larger dominant and co-dominant trees and cutting the smaller diameter, suppressed trees will improve the health and growth rate of remaining trees.

Insects and Diseases - Overview

The three most abundant conifer tree species of commercial importance on the property are ponderosa pine, Douglas-fir and western larch. Lodgepole pine is present but less abundant.

All tree species are vulnerable to insect and disease damage and several native forest health agents are active on the subject property. Eliminating insect and disease damage is nearly impossible but minimizing the potential for insect and disease damage is achievable. A brief description of commonly occurring damaging agents follows as well as management recommendations.

Tree Rusts

Tree rusts are obligate parasites that require living hosts for survival. Management is generally aimed at reducing the disease rather than preventing infections. Young trees with stem cankers should be removed during stand improvement treatments. Trees with multiple stem cankers, spike tops, and girdling stem cankers in the lower to upper third of the crown should also be removed during stand improvement work.

Western Gall Rust – Western Gall Rust is a fungus that infects ponderosa pine and lodgepole pine. The fungus can be identified by looking for galls (round swellings) or cankers (deformities) on the branches and bole of infected trees. This disease mainly causes stem malformation, breakage, reduced growth, and can cause tree mortality in younger trees. Rust spores are windborne and may travel several miles to infect other pines. Due to this high spread area, complete elimination of this disease in unlikely. Eradication of heavily infected trees during future stand improvement treatments is recommended.

Stem Rots and Root Disease

Young trees are practically free from decay because decay cannot start until heartwood formation begins. Young trees with heartwood are liable to decay but it is usually many years later before the decay may become an issue. Stem and butt decays enter living trees through trunk wounds, broken branches and tops, or roots. In old-growth stands, decay fungi cause more volume loss than all other diseases combined. When the increase in decay becomes serious forest stands may need to be cut to avoid economic losses.

Open wounds are avenues for entrance of decay into heartwood. Reducing wounds associated with logging will help reduce the impact of decay fungi. Special care in laying out skid trails and operating equipment during timber harvests will help reduce potential for spread of decay fungi.

Red ring rot fungus (*Phellinus pini*) or Pini can infect all conifer species present on the subject property. Tree damage is heart rot of the main tree stem. Stem decay generally extends several feet above and below observable conks and punk knots on the main tree stem. The presence of several conks or punk knots indicates the tree is a complete cull. Decay can occur anywhere in the main stem though it is most common in the middle and upper portions. The rot first appears as a red or brown stain in the heartwood. The stain often forms concentric rings or crescents in the tree cross section. In later stages, white pockets are distinct from the surrounding dark red or brown wood. In late stages the decay is stringy and mostly white. Swollen knots may be the only outward sign of infection.

Douglas fir is the most common host of Schweinitzii root and butt rot. Infected trees are usually found on poor soils or rocky outcrops. The root disease decays the inner wood of roots and butt heartwood. Crowns of extensively infected Douglas-firs are sometimes thin and show poor shoot growth and some branch die back. Decay is dry and yellow at first, becoming brown and cubically cracked in advanced stages. Douglas-fir beetles often attack infested trees.

The disease often starts in the roots when trees are young but seldom causes root or butt rot until trees are mature or overmature. The cull usually only extends eight feet or less above the ground. Brown cubical decay in the butt end of the first log is the most common indication of schweinitzii root and butt rot.

Pine Bark Beetles

Four common bark beetles can affect the conifer trees in this area. The four beetles are western pine beetle, mountain pine beetle, fir engraver beetle, and pine engraver beetle. The western pine beetle is a major killer of ponderosa pine. Mountain pine beetle kills both lodgepole and ponderosa pine. Pine engraver beetles prefer lodgepole and ponderosa pine. Though usually secondary attackers, pine engraver beetles can become aggressive tree killers during severely dry weather or following stand disturbances. The most important bark beetle enemy of Douglas-fir is the Douglas-fir beetle.

Trees killed by bark beetles turn from green to red during summer months. However, other indicators such as pitch tubes, boring dust, or frass on the bark of the tree are present for several months prior to tree needles turning red.

Pine Engraver Beetles

Pine engraver beetles are slash-breeding insects. The beetles primarily attack fresh, green material on the ground greater than 2 inches in diameter. Examples would be logging slash, tops of trees broken during wind or ice storms, and non-commercial thinning debris. Once green material hits the ground, it is a food source for 3-6 months. After the 3-6 months the sugary layer under the bark turns sour. The pine engraver beetle generally attacks slash in May during its first flight. Another flight will occur 8 weeks later. This second flight will look for green slash; if it is not available they will look for stressed trees and attack the top of the tree.

Normally the top 5-20 feet of the tree is attacked. The top will die, but not the whole tree. Usually another beetle will come in and kill the weakened tree.

To minimize pine engraver attacks avoid creating logging or thinning slash greater than 2 inches in diameter between January and June. If logging is conducted during these times the following suggestions should minimize a pine engraver problem.

1) Proper utilization of all material down to two inches in diameter.
2) Pile and burn material greater than two inches within 6 weeks if possible.
3) Chip or remove material greater than two inches in diameter within 6 weeks.

Douglas-fir Beetle

The most important bark beetle enemy of Douglas-fir is the Douglas-fir beetle. The beetles generally attack mature trees that are water stressed due to drought or over-stocking. The bark beetle bores through the bark and lays its eggs in the cambium layer between the bark and the wood; the cambium is full of sugar and nutrients that feed the larvae. Douglas-fir beetle outbreaks are usually initiated by catastrophic events such as blowdown, or winter breakage. Downed or weakened trees are attacked and beetles build up large populations. The next year, new generations emerge and attack susceptible trees in surrounding stands. Damage in standing trees is greatest in dense stands containing a high percentage of large, mature Douglas-fir.

Salvage of down or weakened Douglas-fir is a primary tool in preventing Douglas-fir outbreaks. When attacks have already occurred removing standing green or faded infested trees will help reduce or prevent further damage in the area. The risk of Douglas-fir beetle damage is reduced when dense mature stands are commercially thinned.

Mountain Pine Beetle

Mountain pine beetle attacks all species of pine, including ponderosa, lodgepole, whitebark and limber pine. It is the most destructive insect pest of pine species in Montana. Adult beetles fly in mid-July through August. Beetles prefer larger diameter trees with a thick layer of phloem- the nutrient conducting layer underneath the bark. The thicker layer in more mature trees provides plenty of food for larval and pupae phases while protecting against temperature extremes.

The female beetle attacks the tree by boring into the bark and then emits an aggregant pheromone that attracts more beetles. This “mass attack” overcomes the trees natural defenses. After the females have laid their eggs, they hatch into larvae and feed out from the main gallery in perpendicular tunnels. It is not uncommon to find small, white larvae at the end of the tunnels. Infested trees are killed by the feeding activity of the larvae, which girdles the tree. Woodpeckers feed on the larvae throughout the winter, and create the distinctive rows of small holes found on the attacked tree. Heavily infested trees are often denuded of their bark by feeding woodpeckers within a few months.

Adult beetles introduce a spore that develops into blue stain fungus that obstructs the trees ability to conduct water and nutrients. Blue stain fungus may also reduce the market value of the timber. The larvae spend the winter under the bark of the tree; pupate in mid-summer, and fly from the

tree as adults. Pro-longed cold snaps of a week or more with temperatures below minus 20 have been known to cause high mortality of the beetle larvae.

It is imperative to remove beetle infested "brood trees" before the larvae emerge and fly in mid-July. Single-storied stands of mature pine trees are most susceptible to severe damage. As the mean diameter of the stand increases, stand susceptibility increases, and finally, the denser the stand is within a given average diameter, the more susceptible it will be to severe beetle-caused mortality.

Dwarf Mistletoe

Dwarf mistletoes are small, leafless, parasitic plants that grow on branches and stems of host trees. The dwarf mistletoe plant completely depends on its tree host for water and nutrients. When an infested tree or branch dies the attached mistletoe plants die as well. The host tree is typically infected by only one species of mistletoe. Dwarf mistletoe affects the growth, form and survival of infected trees and requires a living tree to survive and reproduce.

The plants are 1 to 2 inches tall and mostly yellowish-green in color. Bunched growths of branches (witches' brooms) and swollen branches are frequently caused by mistletoe so they are good places to look for mistletoe shoots.

Dwarf Mistletoe

Female plants produce seeds that spread the disease. Both sexes damage trees. Seeds are produced in small berries. During late summer berries burst and seeds can travel horizontal distances of 10 to 35 feet. The sticky seeds attach to branches and infect them. Birds also carry seeds, but most infection is from nearby infected trees.

Spread is fastest in multi-storied forest stands that are somewhat open. Trees can be infected at any age, but infection is most probable when trees are greater than 10 feet tall. Mature trees with mistletoe infections often have "witches brooms" or large circular clumps of abnormal branch and twig growth in the lower portion of the tree crown. Mistletoe brooms are infected host branches with excessive branching that develop in response to elevated levels of plant growth compounds.

Dwarf mistletoe infection typically begins in the lower tree crown, and vertical spread is slow enough that trees with rapid height growth can outgrow or keep pace with mistletoe spread. Dwarf mistletoe spread is greatest when seeds rain down from infested mature trees in the forest overstory onto smaller trees of the same species on the forest understory. The time it takes mistletoe to kill a tree depends on several factors. Damage tends to develop slowly until the tree is heavily infected. Trees are usually killed within about 10 to 15 years once they become heavily infected throughout the crown. Mortality rates are often highest in mature trees after periods of drought.

Control of dwarf mistletoe involves reducing the amount of mistletoe present in a stand to a low level. Often heavily infected trees are cut. Lightly infected trees can have branches pruned. All live branches up to the highest infected branch should be cut off. Infected trees can be retained if they are isolated from healthy trees or surrounded by resistant tree species within 40 feet.

If the disease is so advanced that most trees need to be cut, planting mistletoe resistant trees is a good alternative. Douglas-fir for example can be replaced with ponderosa pine.

Brooms in trees are often used as nesting and cover sites for birds. Where wildlife objectives take precedence retention of some dwarf mistletoe may be desired to generate snags for cavity nesting wildlife.

Specific Management Strategies for Dwarf Mistletoe Infestations

Sanitation cut - This approach is focused on removal of diseased trees to halt the spread of disease. It may be necessary to return to the stand several years after the 1st removal to remove trees that were not noticeably infected during the 1st stand entry. Single trees or small clumps of infected trees in harvested areas should be removed since they are a significant source of infection for young, understory regeneration. Infected overstory trees should be removed before regeneration reaches 10 years of age. Harvested with larger forest openings can be planted with non-host species such as western larch and ponderosa pine.

Alter Forest Stand Species Composition - This approach emphasizes increasing the relative abundance retention of non-host tree species pine by selective removal of infected trees. The approach is suited to stands were aspen, ponderosa pine and western larch or other desirable species are present in sufficient quantity to meet management objectives. It may be possible to retain young vigorous trees of the host species and larger mature trees that show no evidence on infestation. Periodic monitoring of retained host trees for signs of infection is recommended.

No action - If the host species comprises more than 50% of the stand removal of all host species may leave tree stocking levels to low and adversely affect other natural resource values. Other management objectives may override the necessity of managing a mistletoe infestation.

Mistletoe control is generally a long-term process with activities usually focused around harvest or thinning operations to reduce cost. The first step is to select heavily infected trees for removal during current or future harvests. Second, remove infected young trees during non-commercial thinning operations. Third, prune infected branches off of trees which are left behind but have light infections. Lastly, monitor for mistletoe outbreaks every three to five years.

Mechanical, Abiotic and Animal Damage

Abiotic damages include hail damage and winter damage. All conifer species are vulnerable to damage from climatic factors. Winter damage symptoms usually appear in spring as reddish-brown discolorization of foliage which when viewed from a distance, appears as a horizontal band (red belt) across a slope. In mountainous areas, injury may be confined to an elevational zone corresponding to the pathway of drying winds or to the transition zone between warm and cold air in a temperature inversion. Red belt damage results from the unseasonable occurrence of

warm, dry winds by day, followed by cold air drainage at night, leading to desiccation injury. Frozen soils do not allow lost moisture to be replaced in the needles when used during transpiration. Damaged needles turn yellow to dark brown and are eventually shed. Symptoms are often more pronounced on the windward side of trees. Unopened buds are not usually harmed. Unless damage is severe, most trees usually survive. Damaged trees may be predisposed to attacks by other agents such as beetles.

Animal damage is usually from porcupines killing the tops of pine trees, rodents killing small seedlings, and deer rubbing their antlers or browsing small trees. There was evidence of all of these agents on the property. Currently, none of these are having a significant impact.

To minimize future windfall problems, proper selection of leave trees during harvesting operations is very important. Dominant or co-dominant trees that have a crown ratio that exceeds 35% and a well developed root system should be left.

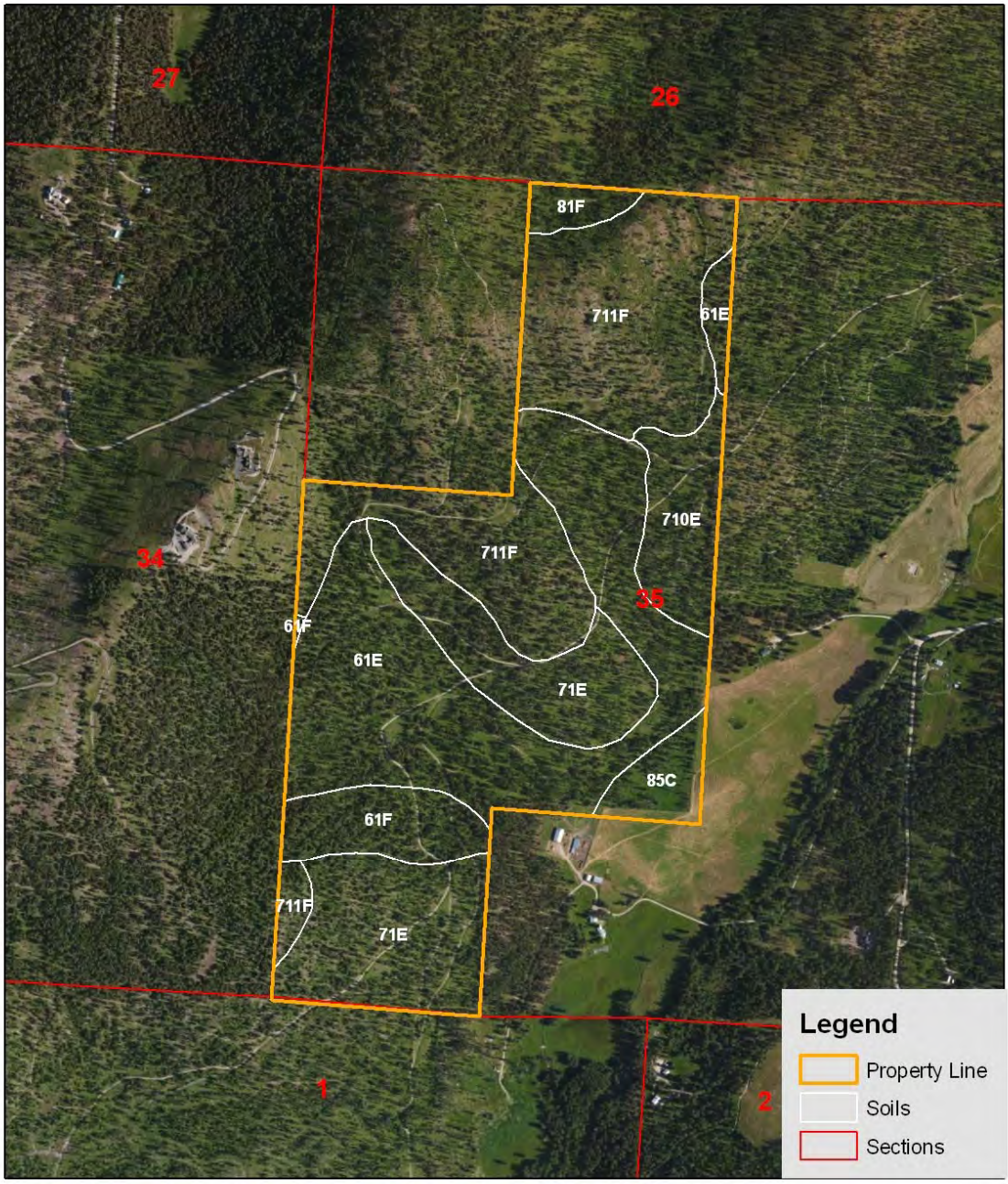
To minimize future windfall problems, proper selection of leave trees during harvesting operations is very important. When leaving trees the dominant or co-dominant trees that have a vigorous crown ratio and root system should be left.

Soils

There are seven different soil types found on Foy's Community Forest. Information for each soil type follows.

Soils Map

Foy's Community Forest Property
T28N, R22W PMM
Flathead County, Montana



Map Made By:
Northwest Management Inc.
1417 Orange Ave
Helena, MT 59624
(406) 442-7555
www.consulting-foresters.com

0 0.125 0.25 0.5 Miles

N

Soil Type Descriptions

Map Unit: 61E—McMannamy gravelly silt loam, 8 to 30 percent slopes

The parent material consists of coarse-silty till derived from calcareous siltstone and/or loamy till derived from argillite. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 50 percent.

Map Unit: 61F—McMannamy gravelly silt loam, 30 to 50 percent slopes

The parent material consists of coarse-silty till derived from calcareous siltstone and/or loamy till derived from argillite. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 50 percent.

Map Unit: 71E—Kingspoint gravelly silt loam, 15 to 30 percent slopes

The parent material consists of coarse-silty till derived from calcareous siltstone. Depth to a root restrictive layer, bedrock, lithic, is 40 to 120 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 50 percent.

Map Unit: 81F—Foyslake gravelly silt loam, 30 to 50 percent slopes

The parent material consists of loamy till derived from argillite and/or coarse-silty till derived from calcareous siltstone. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 50 percent.

Map Unit: 85C—Kila ashy silt loam, 0 to 8 percent slopes

This soil type is present on stream terraces. The parent material consists of coarse-silty alluvium over till. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is moderately well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is high. Shrink-swell potential is low. This soil is not flooded. It is not ponded. A seasonal zone of water saturation is at 48 inches during April, May, June. Organic matter content in the surface horizon is about 50 percent. Nonirrigated land capability classification is 4e. Irrigated land capability classification is 4e. This soil does not meet hydric criteria. The calcium carbonate equivalent within 40 inches, typically, does not exceed 25 percent.

Map Unit: 710E—Kingspoint-McMannamy gravelly silt loams, 8 to 30 percent slopes

The parent material consists of coarse-silty till derived from calcareous siltstone. Depth to a root restrictive layer, bedrock, lithic, is 40 to 120 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 50 percent.

Map Unit: 711F—Kingspoint-Sharrott-Rock outcrop complex, 15 to 50 percent slopes
The parent material consists of coarse-silty till derived from calcareous siltstone. Depth to a root restrictive layer, bedrock, lithic, is 40 to 120 inches. The natural drainage class is well drained. Water movement in the most restrictive layer is moderately high. Available water to a depth of 60 inches is moderate. Shrink-swell potential is low. This soil is not flooded. It is not ponded. There is no zone of water saturation within a depth of 72 inches. Organic matter content in the surface horizon is about 50 percent.

Soil Suitability Chart – Hand Planting, Soil Rutting, and Erosion Hazard
Ratings in the column *Suitability for Hand Planting* are based on slope, depth to a restrictive layer, content of sand, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, poorly suited, or unsuited to these methods of planting. It is assumed that necessary site preparation is completed before seedlings are planted.

The ratings in *Soil Rutting Hazard* indicate the hazard of surface rut formation through the operation of forestland equipment. Soil displacement and puddling (soil deformation and compaction) may occur simultaneously with rutting. Ratings are based on depth to a water table, rock fragments on or below the surface, the Unified classification of the soil, depth to a restrictive layer, and slope. The hazard is described as slight, moderate, or severe. A rating of "slight" indicates that the soil is subject to little or no rutting. "Moderate" indicates that rutting is likely. "Severe" indicates that ruts form readily.

Ratings in the column *Erosion Hazard* indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. A rating of “Moderate” indicates that some erosion is likely and that erosion control measures may be needed. “Severe” indicates that erosion is very likely and that erosion control measures. Including revegatation of bare areas, are advised.

Soil Type Description	Suitability for Hand Planting	Soil Rutting Hazard	Erosion Hazard (after disturbance)
61E-McMannamy gravelly silt loam, 8 to 30 percent slopes	Well suited	Moderate	Moderate
61F-McMannamy gravelly silt loam, 30 to 50 percent slopes	Moderately suited	Moderate	Severe
71E-Kingspoint gravelly silt loam, 15 to 30 percent slopes	Well suited	Moderate	Moderate
81F-Foyslake gravely silt loam, 30-50 percent slopes	Moderately suited	Moderate	Severe
85C – Kila ashy silt loam, 0 to 8 percent slopes	Well suited	Severe	Slight
710E-Kingspoint-McMannamy gravelly silt loams, 8 to 30 percent slopes	Well suited	Moderate	Moderate
711F-Kingspoint-Sharrott-Rock outcrop complex, 15 to 50 percent slopes	Moderately suited	Moderate	Moderate

Aesthetics and Recreation

Maintenance of an aesthetically pleasing forest landscape is a forest management objective for the ownership. Scenic quality is an important attribute of a quality recreational experience. Additionally maintenance of scenic quality is perceived as a component of good forest land management by a significant compontent of the public. Tourism is an important facet of the local economy and visitors to the area value the opportunity to view open spaces and relatively natural landscapes. Potential impacts to aesthetic quality related with forest management activities are typically associated with timber harvests, wildfires, and forest roads. Potential impacts from these occurances are a management concern across the ownership

Visual impacts associated with timber harvests can be mitigated in a number of ways. Replicating patterns of natural disturbances in the design of timber harvest units can help to maintain a “natural” appearing landscape. Limiting the size of timber harvest units and the intensity of harvesting within units may not replicate the pattern a natural disturbance of a stand replacement wildfire but does lessen visual impact on the landscape. Stands in which clearcuts may be the preferred management alternative can be treated in a “staggered manner” utilizing a series of smaller patch cuts or clearcuts over a time period of several decades versus a single large scale entry. Selection harvests along roadways, trails, and highly visual areas can be modified to maintain a higher degree of crown cover. This is especially important on steep highly visible slopes. Development of uneven-aged forest structures in visually important areas can reduce the need to significantly reduce tree crown cover during a harvest entry. It also provides an opportunity to retain large diameter old growth trees and “character trees” that appeal to a public that values a natural appearing landscape.

Utilization of timber harvest technology that minimizes soil disturbance will reduce visual impacts. Forest treatments can be conducted on dry or frozen ground to minimize soil disturbance. Where soil disturbance does occur prompt seeding of disturbed soils will promote quick establishment of ground cover.

Where forest road construction is necessary roads can be located to minimize visual impacts. Avoiding road construction on steep slopes minimizes exposure of cut and fill slopes. Developing cooperative road use agreements with neighboring ownerships can reduce the need for new road construction. Maintaining a higher degree of forest cover adjacent to roads can help to screen them. Eliminating the need for forest road construction can be accomplished through use of alternative harvest methods such as cut-to length systems utilizing forwarders, helicopter logging, and cable based systems that partially suspend logs. Avoiding use of ground based harvest equipment of slopes that exceed 45% will limit visual impacts associated with rutting, skid trail construction and soil disturbance.

Forest management practices that reduce fuel loading will decrease the risk of catastrophic fire. The visual and environmental effects of high intensity fires can remain on the landscape for decades and are generally viewed as undesirable by the public.

Implementing forest management practices that reduce the risk of insect and disease infestation can minimize the extent of impacted areas and reduce the necessity of treating large forested areas that have been severely impacted in a short period of time.

Forest Road Management

Benefits and Potential Impacts of Forest Roads

Forest road systems provide numerous benefits such as providing access for timber harvesting, livestock grazing, recreation, fire control, recreation, and land management. The harvest of forest products usually depends on road access, and decreased road densities can result in increased timber harvesting costs. Roads provide access that can increase the efficiency of fire suppression and can act as linear firebreaks that reduce fire spread.

Detrimental effects associated with roads include sedimentation, habitat fragmentation, loss in soil productivity, invasion by noxious and exotic weeds, use conflicts and destructive human actions such as trash dumping, illegal hunting and wildfires. Weed species that disperse along roadsides can spread to adjacent native plant communities. Actively controlling access, when and how people are permitted to use roads is important if detrimental effects are to be mitigated.

Surface erosion from road surfaces, cut banks, and ditches can be a significant source of sediment in streams. Rates of sediment delivery are highest in the first five years following road construction and can be closely related to traffic volume on unpaved roads. Surface erosion problems are worse where roads are constructed on highly erodable soils. Lack of road maintenance or poorly timed maintenance can contribute to increases on sediment production on existing roads. Implementing improved road construction standards and actively maintaining roads will reduce road related surface erosion. Road location, design, construction and maintenance is especially critical near streams. Placement of surfacing material, installing proper

drainage structures and prompt establishment of vegetation on road surfaces are actions that will reduce sediment production from road surfaces.

Increased road access can accelerate rates of wildlife harassment and poaching. Several wildlife species have been shown to be adversely effected by encounters with people on roads. For example, elk avoidance of roads is a learned response, and is related to traffic volume and hunting pressure. Other road related consequences to wildlife can include removal of snags near roadsides by firewood cutters. Removal of snags eliminates habitat for many cavity–nesting birds and mammals.

Active road system management will enhance benefits received from the existence of a road system. Many of the detrimental affects associated with roads can be mitigated through planning, access control, maintenance and restricting how and when roads are utilized by people and vehicles. Roads with chronic sedimentation or erosion problems can be rehabilitated, relocated or decommissioned.

Cultural Resources

Cultural resources are evidence of past human activity. They include pioneer homes, farm and ranch buildings, historic railroads, town sites, historic or prehistoric artifacts, rock writings, burial sites, battlefields, American Indian camp sites, stone alignments, buffalo jump sites, or historic irrigation canals.

Cultural resources can also include certain landforms that take on different levels of historic or spiritual meaning. People may value these sites because of their ethnic heritage or their association with past or present community traditions. Land forms or spiritual sites may be sacred to people as a source of life and spiritual energy because of their cultural and spiritual significance.

Cultural resources are nonrenewable. That is, once damaged or destroyed, they cannot be replaced. They often provide important information about past societies and environments, and that information can provide solutions for modern conservation concerns.

The subject property has no known historical building structures and no cultural resources were observed during forest inventory work conducted on the property for the puposes of this report.

Noxious Weed Management

Noxious weeds degrade wildlife habitat, diminish rangeland forage productivity, increase erosion potential and can poison and injure livestock. By definition, noxious weeds are plant species that are harmful to the environment. Eradication and restoration require that noxious weeds be killed. Noxious weeds are invaders and do not succumb to eradication, prevention, or restoration easily and so controlling noxious weeds is expensive and time consuming.

With the high use of the roads and trails by the public, watching for the introduction of noxious weeds will be an ongoing task. Several of the noxious weeds that are most common in western Montana are further discussed in the Appendix to this report.

Montana County Noxious Weed Control Law

The Montana County Noxious Weed Control Law (MCA 7-2101 through 2153) was established in 1948 to protect Montana from destructive noxious weeds. This act, amended in 1991, has established a set of criteria for the control and management of noxious weeds in Montana. Noxious weeds are defined by this act as being any exotic plant species which may render land unfit for agriculture, forestry, livestock, wildlife or other beneficial uses or that may harm native plant communities. Plants can be designated statewide noxious weeds by rule of the Department of Agriculture or county-wide noxious weeds by district weed boards following public notice of intent and a public hearing.

The Montana noxious weed law only pertains to noxious weeds. It cannot be enforced on any weed not designated as a statewide or district noxious weed**.** The noxious weed control law establishes weed management districts throughout the state. These management districts are commonly called county weed control districts and are defined by the boundaries of the county.

The Montana County Noxious Weed Control Law declares noxious weeds--and noxious weed seeds--to be a common nuisance. **It is unlawful for any person to permit any noxious weed to propagate or produce seeds on their land** unless the landowner adheres to the noxious weed management program of their county, or has entered into and is in compliance with a written noxious weed management plan for their property. To be valid, this written noxious weed management plan must be approved and signed by the district weed board chairman.

The county weed control district is responsible for developing a district wide noxious weed management plan to help county residents comply with the Montana County Noxious Weed Law. This plan must be made available to the public for review at the district office. The County Weed District should be contacted for more information on effective weed control methods.

Weed Control Methods

Various control methods are available for noxious weeds. Chemical controls are very effective for many species. Persistently applied mechanical control can keep weed growth in check to a point where the plants will not proliferate. To be effective, however, the application must be reapplied on a regular basis. The length of time between treatments varies depending on weed species and the environmental conditions. Biological controls are available for some species.

Weed infestations confined to small, well-defined areas should be treated as soon as detected to avoid spread of the weed. Timely control of a few plants will be very cost effective compared to treating a larger acreage later.

An active weed control program could include:

- Limiting access to motorized vehicles
- Pressure washing vehicles to insure weed seed free prior to allowing access
- Aggressive chemical treatment of known populations - Restricted use pesticides must be applied by a licensed applicator. Note that many herbicides will kill conifer trees so extra precautions are necessary in forested areas. Local weed districts and MSU county extension agents are excellent sources for current weed control information.

- Grass seeding - important grass characteristics to be considered for long-term control of problem weeds include: adaptation to the soil and climate, ease of establishment, competitiveness with weeds, palatability and nutritional value to wildlife and livestock

Appendix

Glossary of Terms
Species of Concern Data Report and Map
Characteristics and Control of Noxious Weeds Common to the Vicinity
Characteristics of Major Tree Species Present on Foy's Community Forest
References and Sources

Glossary of Terms

EVEN-AGED STAND:--A stand is generally considered even-aged if the difference between the oldest and youngest tree does not exceed 20% of the length of the rotation.

CLEARCUT:--Removal of the entire stand in one cutting.

REGENERATION:--Obtained by planting or natural seeding from adjacent stands.

SEED TREE:--Removal of the mature timber in one cutting, except for a small number of seed trees left singly or in groups.

UNEVEN-AGED MANAGEMENT:--An uneven-aged stand contains at least three age classes intermingled on the same area. A balanced uneven-aged stand consists of 3 or more different age classes each occupying an approximately equal area.

SINGLE TREE SELECTION:--Removal of single mature individuals or very small groups of mature trees. This favors the development of shade tolerant species in most cases. Logging by this method is usually difficult and expensive.

GROUP SELECTION:--Removal of all mature timber in a small area, usually less than one acre but up to three acres in size. This creates an aggregation or mosaic of even-aged clumps, with clumps of differing ages. This modification is more readily adapted to a wide variety of conditions than any other. The ecological requirements of most species can be met within its framework. It is also easier to create the kinds of environmental conditions necessary for reproduction. The openings can be allowed to seed in naturally or can be planted if particular species are desired and their establishment is expected to be difficult.

OVERSTORY REMOVAL:--Removal of all material over a certain size (usually 9" DBH) where a manageable understory is present. The understory should be uniform, healthy, vigorous and composed of desirable species. This technique often leaves suppressed and poorly formed trees as part of the residual stand.

COMMERCIAL THIN:--Can be applied to even or uneven-aged stands. Commonly used to describe operations that are designed to control stocking, improve spacing between trees or remove trees of poor vigor or form. Harvested trees are large enough to be sold as wood products, including sawlogs, chip-and-saw or small sawlogs, pulp and fiberwood.

SANITATION/SALVAGE:--Removal of dead, dying, diseased or high risk trees. Typically a light harvest, this technique sometimes treats the symptoms rather than the problems.

Species of Concern Data Report and Map

Montana Natural Heritage Program

Species of Concern Data Report

Visit http://mtnhp.org for additional information.

Report Date: Thursday, March 29, 2012

Rana pipiens — View Species in MT Field Guide

Common Name: Northern Leopard Frog
General Habitat: Wetlands, floodplain pools
Description: Vertebrate Animal
Mapping Delineation:
Standing water bodies with confirmed evidence of reproduction (calling adults, eggs, larvae or new metamorphs) buffered by 100 meters in order to reflect importance of adjacent terrestrial habitats to survival of breeding adults and newly metamorphosed juveniles.

Species Status — Click Status for Explanations

Natural Heritage Ranks:
State: S1,S4
Global: G5

Federal Agency Status:
U.S. Fish & Wildlife Service:
U.S. Forest Service: SENSITIVE
U.S. Bureau of Land Management: SENSITIVE

FWP CFWCS Tier: 1

MT PIF Code:

Species Occurrences

Species Occurence Map Label: 309790
First Observation Date: 1997-09-22
Last Observation Date: 1997-09-22
SO Number: 6
Acreage: 26
SO Rank:

Ardea herodias — View Species in MT Field Guide

Common Name: Great Blue Heron
General Habitat: Riparian forest
Description: Vertebrate Animal
Mapping Delineation:
Confirmed nesting area buffered by a minimum distance of 6,500 meters in order to be conservative about encompassing the areas commonly used for foraging near the breeding colony and otherwise buffered by the locational uncertainty associated with the observation up to a maximum distance of 10,000 meters.

Species Status — Click Status for Explanations

Natural Heritage Ranks:
State: S3
Global: G5

Federal Agency Status:
U.S. Fish & Wildlife Service:
U.S. Forest Service:
U.S. Bureau of Land Management:

FWP CFWCS Tier: 3

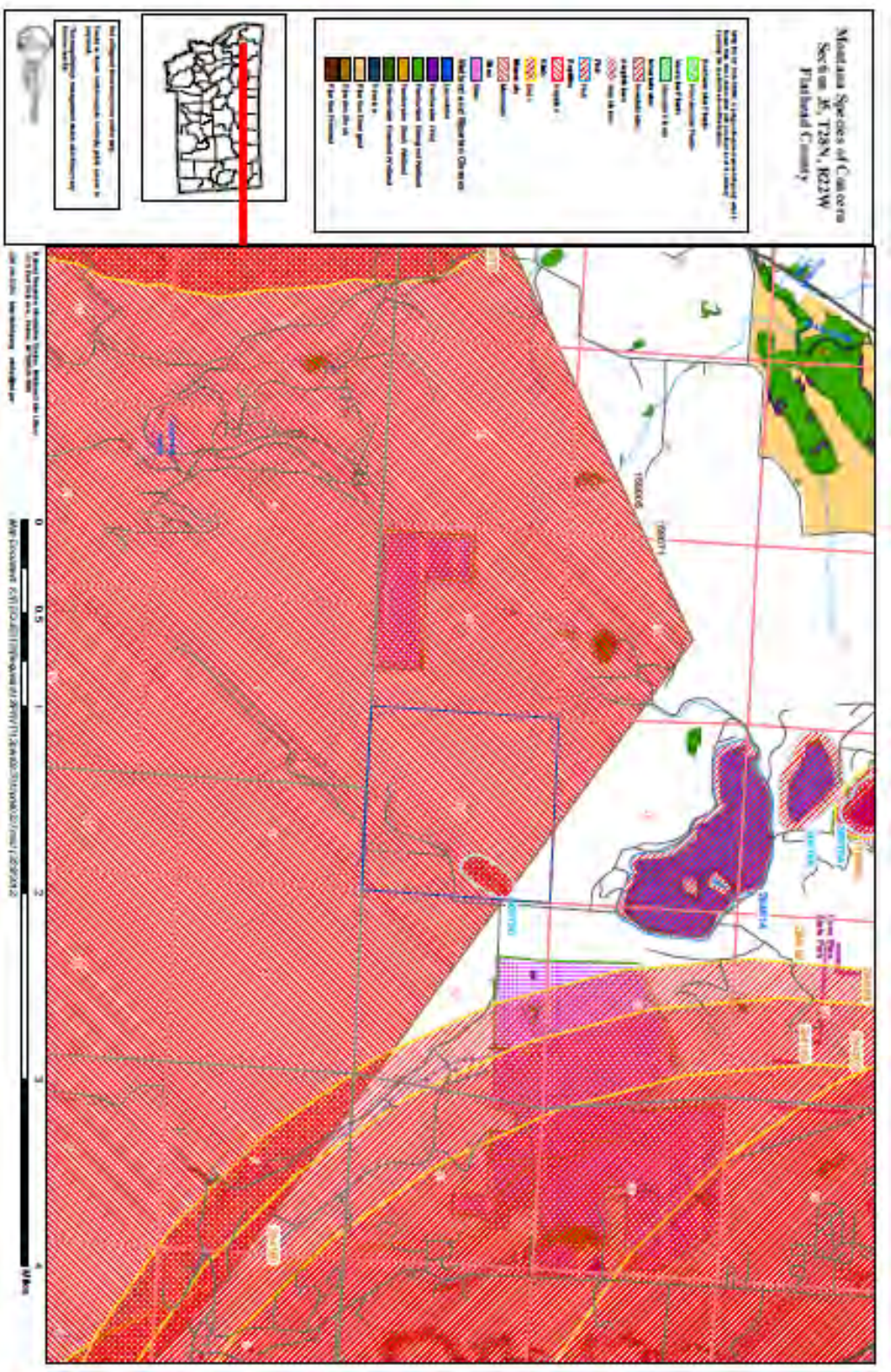
MT PIF Code:

Species Occurrences

Species Occurence Map Label: 294194
First Observation Date: 1974-02-16
Last Observation Date: 1979-12-14
SO Number: 595
Acreage: 32,632
SO Rank:

Species Occurence Map Label: 294192
First Observation Date: 1985-02-16
Last Observation Date: 1985-12-14
SO Number: 700
Acreage: 32,632
SO Rank:

Montana Natural Heritage Program Species of Concern Report — Page 1 of 3


Montana Species of Concern
Section 35, T28N, R22W
Flathead County

Characteristics and Control of Noxious Weeds Common to the Vicinity

Spotted Knapweed (Centaurea maculosa Lam.)

Spotted Knapweed was introduced from Europe and is widely dispersed in the western United States. Each plant produces up to 25,000 seeds that is dispersed by wind, animals, and people. Seeds can remain viable for up to 8 years. This weed is common throughout Montana.

Description

Spotted knapweed generally is a short-lived perennial, reproducing solely by seeds. Seeds are brownish, less than 1/4 inch long, notched on one side of the base, with a short tuft of bristles at the tip. The seeds may germinate from spring through early fall. Seedlings emerging in the fall often over-winter as a rosette of leaves, resuming growth again in the spring. The plant grows 2 to 4 feet tall and bears alternate, pale green leaves which are 1 to 3 inches long. Leaf margins of the lower leaves are divided and smooth while the surface of the leaf is rough. The upper leaves are linear in shape. Stems are erect and rough, with slender branches. Numerous flowers are produced from early July through August. Flowers are pink to light purple and are borne on tips of terminal or axillary stems. The flower petals are surrounded by stiff, black-tipped bracts, giving the flower head a spotted appearance.

Control

Several biological control agents are available including root boring beetles and moths, seed head gall flies, and seed head weevils. The success of these agents is fair to good under most conditions. Several herbicides are also available. The success to these control agents area generally good; however, re-application is often recommended due to the viability of the seeds remaining in the soil.

Prevention—Management

People are the major cause of spotted knapweed spread. The weed is spread readily in hay and on vehicle undercarriages. Producers should exercise caution when using hay from road ditches, especially primary roadways, and when purchasing hay from known infested areas in neighboring states.

Producers must learn to identify spotted knapweed and be aware of potential harmful effects before it becomes established. Producers should watch for the weed on their own land, especially on disturbed sites, pastures bordering roads and streams, and where hay is fed. Timely control of a few plants will be very cost effective compared to treating a larger acreage later.

Pasture and Rangeland

The best spotted knapweed control is prevention. The plant generally is easy to control with herbicides but an area must be monitored for several years and retreated as necessary for seedling control.

Picloram (Tordon) at 0.25 to 0.5 pounds (1 to 2 pints) per acre will control spotted knapweed plants and seedlings for two to three years. The residual control period may be shorter on gravel soils, in wet areas, and where soil organic matter is high. The optimum application time is when the plant is in the rosette growth stage in the fall or in the bud to bloom stage in the spring. Picloram should not be used near water or where a sandy porous surface and substrata overlie ground water 10 feet or less below the surface.

Dicamba (Banvel) at 1 to 2 pounds (1 to 2 quarts) per acre will give good spotted knapweed control, but residual control of seedlings is shorter than with picloram. An annual follow-up treatment of 2,4-D at 1.0 pound (1 quart of a 4-pound-per-gallon concentration) per acre for a minimum of two years may be needed to prevent reinfestation by seedlings. No waiting period is required for non-dairy animals. Meat animals should be removed from dicamba treated areas 30 days prior to slaughter.

Clopyralid + 2,4-D (Curtail) will provide good control of spotted knapweed with less soil residual than picloram or dicamba. Control is greatest when fall applied at 0.19 + 0.28 + 1 to 1.5 pounds per acre (4 to 6 pints per acre of Curtail). A follow-up treatment the following year may be necessary to control seedlings.

Picloram and dicamba are expensive treatments, especially if spotted knapweed infests a large area. Spotted knapweed can be controlled in the rosette stage in the fall or early spring by 2,4-D low volatile ester, oil soluble amine or water soluble amine formulations at 2 pounds (2 quarts of a 4-pound-per-gallon concentration) per acre. Application of 2,4-D after stem elongation of spotted knapweed is not very effective. No residual control is provided by 2,4-D, and annual spraying is necessary until spotted knapweed seed is no longer viable. This may require several years of annual treatment.

Small Infestations

Spotted knapweed confined to small, well-defined areas should be treated as soon as detected to avoid spread of the weed. First, all visible spotted knapweed plants should be removed and destroyed. Then the area should be treated with a herbicide to prevent reinfestation from seedlings.

Picloram, dicamba, or clopyralid + 2,4-D (Curtail) can be used to control small infestations. One to two ounces per gallon of either of these herbicides should be mixed in a hand-held single nozzle sprayer and applied until runoff. Treat an extra 10 to 15 feet around the spotted knapweed patches to control roots and seedlings. A careful follow-up program is necessary to control missed plants and seedlings. Many attempts to control spotted knapweed have failed because follow-up treatments were not applied.

Hounds tongue (Cynoglossum officinale)

Hounds tongue is a member of the Borage family. It is a biennial that is introduced from Europe. It reproduces by seeds and appears as a leafy rosette in its first year. The stem is erect, stout, heavy, 1-1/2 to 3 feet high, usually branched above. The leaves are alternate, the basal and lower ones are broad, and are oblong to lance-shaped. The upper leaves are narrower and pointed, almost clasping. The flowers are terminal and reddish-purple in color. The fruit consists of four nutlets (seeds), each about 1/3 inch long, with the outer surface covered with short, barbed prickles. Nutlets break apart at maturity and are rapidly scattered by animals.

Hounds tongue is toxic to livestock. This plant contains alkaloids that cause liver cells to stop producing. Animals may survive for six months or longer after they have consumed a lethal amount of the plant. Although most animals will avoid hounds tongue in the field, if even a small portion of a hounds tongue leaf, for example, were to be included in hay, the animal will not avoid it. In this situation, there have been reported cases in Larimer County, Colorado of death to livestock. This plant is not native to the United States. The leaves are rough and resemble a hound's tongue.

Methods of Control

Mechanical control

Due to the rhizomes of this perennial weed, mechanical control provides little or no control. In addition, the areas where hounds tongue tends to grow (i.e. wetlands) are impractical for tillage. Research from the University of California has shown that mechanical top removal treatments do not reduce hounds tongue densities. Research from Colorado State University showed that hand pulling or mowing controlled only 4% and 5% of hounds tongue.

Chemical control

In general, effective chemical control requires multiple applications. Timing and application rate are crucial for successful control. Again, application rate is critical; hounds tongue can be controlled by the chemical imazapic. Brands of herbicides that contain this chemical are Plateau and Oasis. These chemicals can be applied as either pre- or post-emergent. They should be applied at 8-12 ounces per acre. No more than 12 ounces/Acre of Plateau should be applied per year.

Biological control

No effective agents are known at this time; however, research in this area persists.

Cultural control

Hounds tongue might be managed temporarily with herbicides or, in the future, with insects, but long-term reductions must include planting competitive plant species to occupy bare ground once infested by the weed. Many improved grass species can be seeded in late fall or winter when seedbeds are properly prepared. An initial herbicide treatment is important to suppress problem perennial weeds before seeding.

Important grass characteristics to be considered for long-term control of problem weeds include 1) adaptation to the soil and climate, 2) ease of establishment and 3) competitiveness with weeds.

Thistles

Most thistles in the western United States are native species that generally go unnoticed and likely will never cause significant losses as weeds. However, thistle species introduced from Europe, Africa, and Asia can be very aggressive opportunists. They often invade overused or otherwise disturbed land. The plants spread rapidly, out-compete established and introduced plant species for nutrients, and can render pastures, rangeland, and forests nearly unusable.

Thistles are especially troublesome following cool wet summers and falls, when seed production and seedling establishment are high. An integrated weed control program that combines chemical, cultural (such as crop rotation or grass competition), mechanical and biological methods is most likely to be successful.

Keys to controlling all thistles include:

- Establish a three to five year management program using several integrated methods.
- Control small patches before they spread.
- Use proper stocking rates and rotate pastures.
- Reseed disturbed areas immediately with desired species.

Biennial Noxious Thistles

Biennial thistles such as musk (*Carduus nutans* L.), plumeless (*Carduus acan-thoides* L.), and bull thistle [*Cirsium vulgare* (Savi) Tenore] are not as difficult to control as the perennial thistle species but spread rapidly by seed and can become severe problems in some areas. All biennial thistles considered noxious are native to Europe or Eurasia and were introduced into North America as seed contaminants. Biennial thistles spread by seed that are produced in great number by all the noxious species, ranging from 8400 seeds per plant with plumeless thistle to 120,000 seeds per plant from musk thistle.

Biennial thistle seed generally germinates in the summer and fall, and the plant over-winters as a rosette. The following spring the plant resumes vegetative growth, bolts, and flowers. Numerous, generally large flower heads are produced from May to October depending on the species. After setting seed, the plants die thereby completing the life cycle. Occasionally biennial thistles have winter annual, annual, or short-lived perennial characteristics.

Biennial thistles tend to invade over-grazed or otherwise disturbed pastures, rangeland, roadsides, and waste areas. Movement into cropland is generally from nearby non-cropland or

roadsides. Biennial thistles reproduce only from seed, so the key to a successful management program is to control the plants before flowering. season's growth.

Musk thistle (Carduus nutans)
Musk thistle is one of the more common biennial noxious thistles and is relatively easy to identify because it often grows in excess of 6 feet tall, has very large flowers that tend to droop, and the flower has very characteristic brown bracts that resemble pine cones. The flowers usually are deep rose in color, solitary, and very large ranging from 1.5 to 3 inches in diameter. The average musk thistle plant produces in excess of 10,000 seeds per plant and under favorable conditions may produce 120,000 seeds per plant. Seed germination generally averages 30%. Rosettes are dark green with a light green midrib and often grow 2 feet in diameter or more. Rosette leaves are usually smooth and lacking pubescence.

Musk thistle generally invades areas that are especially dry and over-grazed. Musk thistle seed is readily dispersed after introduction, so plants cover many acres in only one or two seasons. Infestations are generally more dense than with other biennial thistles, but less dense than perennial noxious thistles. Flowering is indeterminate, starting in early June and continuing for at least 8 to 10 weeks. A late-blooming cycle often occurs just prior to frost. Seed from the late-bloom is primarily responsible for the limited success of seed-feeding weevils (*Rhinocyllus conicus*) introduced for biological control of musk thistle. These insects attack the earlier blooms but have completed their life cycle before the last flowers set seed.

Bull thistle (Cirsium vulgare)
Bull thistle is generally the least serious of the noxious thistles. It occurs in all 48 contiguous states and most of Canada, but is designated noxious in only four states. The plant is fairly short growing, 2 to 5 feet. A distinguishing characteristic of bull thistle is the leaves. Leaf margins are deeply toothed, and toothed again (double dentate) with prominent stiff spines. The leaves have prickly hairs above and are cottony below. The plant appears bushy rather than the candelabra appearance of plumeless or Canada thistle.

The seeds readily germinate; however, survival is low and bull thistle is generally found as single or only scattered plants. The rosettes of bull thistle are very pubescent with dark purple ribs. The heads are gumdrop-shaped with long stiff yellow tipped spines. Bull thistle flowers from July to September, which is somewhat later then other thistles in the region. The flowers are usually purple, but a rare white flowering variety has been collected in the region.

Perennial Native and Noxious Thistles
Perennial thistles such as Canada [*Cirsium arvense* (L.) Scop.], Flodman thistle [*C. flodmanii* (Rydb.) Arthur], and wavyleaf thistle [*C. undulatum* (Nutt.) Spreng.], are generally more difficult to control than the biennial thistles because they spread by both root and seed. Top growth control is not enough; one must design a program to deplete the root system for effective control of a perennial thistle.

Both wavyleaf and Flodman thistle are native species that generally are only a problem when the land has been overused. Canada thistle was introduced from Europe and like many introduced weeds has spread rapidly because of the lack of natural enemies. All perennial noxious thistles are aggressive invaders and can become the dominant species in an area within a few seasons of introduction if not properly controlled.

Canada Thistle (Cirsium arvense)

Canada thistle was introduced in North America as a seed contaminant in both French and British colonies. The first legislation to control the weed was passed by Vermont in 1795. The native distribution of Canada thistle includes Europe, North Africa, and central Asia. It is also found in China and Japan and has spread so extensively that it is difficult to distinguish the plant's original native range. Canada thistle grows best in the northern regions of North America where temperature and rainfall are moderate. Canada thistle is adapted to a wide range of soils, but it produces deeper roots in clay or muck soils than in sand, gravel, or limestone soils. Canada thistle requires a 14 to 16 hour photoperiod to bolt and flower, and growth ceases when temperatures exceed 85° for extended periods. Canada thistle is considered to be naturalized in the northern Great Plains.

Canada thistle usually grows 2 to 3 feet tall and bears alternate, dark green leaves that vary in size. The leaves are oblong, usually deeply cut, and have spiny, toothed edges. Canada thistle has small (three-fourths inch diameter), compact flower heads that appear on the upper stems and range in color from lavender to pink or white.

Canada thistle has been classified into several varieties. Within these varieties are many ecotypes that differ in growth characteristics, response to day length, and susceptibility to herbicides and cultivation. For example, leaf shape, head structure, and the number and size of spines can differ with ecotype. Flower color can range from purple to light lavender or even white. Stem color also can differ from green to lavender. Some ecotypes show variable response to herbicides and/or cultivation.

Flowering occurs from June to September. Male and female flowers are produced on different plants, so cross-pollination is necessary for seed production. Flowers produce from 40 to 80 seeds per head. The smooth, light brown seeds have a conical point and are loosely attached to a tannish pappus at the tip, which aids in seed dispersal by wind. Seeds mature rapidly and are able to germinate within eight to 10 days after pollination.

Canada thistle generally spreads from field to field in contaminated crop seed or forage. Within a Canada thistle population some seed remains in the flower head or falls at the base of the plant.

The remaining seed can be dispersed by wind, either attached to the cottony pappus in late summer or later in the winter when it is moved by wind driven snow across fields.

Once the plant becomes established, roots are the most important means of propagation. Canada thistle has an extensive underground root system that may penetrate the soil to a depth of 10 feet or more and grow laterally 12 to 15 feet per year. Root buds occur randomly along the roots and initiate new shoots whenever environmental conditions are favorable. Root segments as small as 0.6 inch can initiate shoot growth and become established.

Characteristics of Major Tree Species Present on Foy's Community Forest

This section describes the physical and biological characteristics of the major tree species found on the property. Understanding of these characteristics will improve the forest manager's decision making and provides a rational for the management of various tree species.
The U.S. Forest Service publication: *Silvics of North America: Volume 1. Conifers* was referenced as the source for most information provided in this section (USDA-Forest Service, 1990). United States Department of Agriculture - Forest Service. 1990. *Silvics of North America: Volume 1. Conifers.* Agriculture Handbook 654. 675 Pages.

Lodgepole Pine

Climate

Lodgepole pine grows under a wide variety of climatic conditions. Temperature regimes vary greatly. Minimum temperatures range from 45° F on the coast to -70° F in the Northern Rocky Mountains. Maximum temperatures range from 80° F at high elevations to well over 100° F at the lower elevations in the interior. Average July minimums frequently are below freezing at high elevations. Lodgepole seedlings are relatively resistant to frost injury and often survive in "frost-pockets" where other species do not.

Lodgepole pine can grow in areas receiving only 10 inches of annual precipitation, or in areas receiving more than 200 inches. Seasonal distribution of precipitation is significant; snowfall supplies most of the soil water used for rapid growth in the spring and early summer. Temperatures are frequently favorable for germination after snowmelt, and germination occurs rapidly. Lodgepole is very intolerant of shade and generally grows best in full sunlight.

Soils and Topography

Lodgepole pine grows on soils that vary widely but are usually moist. Growth is best where soil parent materials are granites, shale, and coarse-grained lavas; other soils have developed from glacial till of varying composition including Recent, Tertiary, and Oligocene alluvium and colluvium from sources such as quartzite and argillites, limestone of the Belt geologic series, pumice, and volcanic ash. Lodgepole pine is seldom found on the generally drier soils derived from limestone. In Montana, highly calcareous soils derived from dolomitic limestone usually do not support lodgepole pine. Nevertheless, soils developed in colluvium from other types of limestone and calcareous glacial till do support stands of lodgepole pine.

Soil properties and soil moisture often favor lodgepole pine locally over other species. Lodgepole pine grows on wet flats and poorly drained soils. Soils with underlying hardpan support lodgepole pine to the exclusion of such species as ponderosa pine or Douglas-fir. Lodgepole pine also grows on level sites with and without high water tables where frost tolerance during germination allows its establishment to the exclusion of other species. Extensive stands are found in these areas on well-drained sites above 5,250 feet, with patterns of occurrence attributed to past fires.

On infertile soils, lodgepole pine is often the only tree species that will grow. Nevertheless, experiments have demonstrated significant growth increase from fertilization, particularly nitrogen.

Lodgepole pine thrives in a wide variety of topographic situations. It grows well on gentle slopes and in basins, but good stands are also found on rough and rocky terrain and on steep slopes and ridges, including bare gravel. Northern and eastern slopes are more favorable than southern and western aspects.

Associated Forest Cover

Lodgepole pine grows both in extensive, pure stands, and in association with many western conifers. The forest cover type Lodgepole Pine exists as a pure (80 percent or more) component of basal area stocking, as a majority (50 percent or more), or as a plurality (20 percent or more). The lodgepole pine forest type is the third most extensive commercial forest type in the Rocky Mountains.

Lodgepole pine's successional role depends upon environmental conditions and extent of competition from associated species. Lodgepole pine is a minor seral species in warm, moist habitats and a dominant seral species in cool dry habitats. Fire regimes have played a significant role in this successional continuum, especially where repeated fires have eliminated a seed source for other species.

Lodgepole pine may even overwhelm a site with seed stored in serotinous cones. It has four basic successional roles:

Minor Seral- A component of even-aged stands rapidly being replaced by shade-tolerant species in 50 to 200 years.

Dominant Seral- The dominant cover type of even-aged stands with a vigorous understory of shade-tolerant species that will replace lodgepole pine in 100 to 200 years.

Persistent- The dominant cover type of even-aged stands with little evidence of replacement by shade-tolerant species.

Climax- The only tree species capable of growing in a particular environment; lodgepole pine is self-perpetuating.

Flowering and Fruiting- Male and female strobili are born separately on the same tree in this monoecious species. Female flowers most often at the apical end of main branches in the upper crown, and male flowers on older lateral branches of the lower crown. The reddish purple female flowers grow in whorls of two to five and are ½ inch long. The pale yellows to yellowish orange male flowers are crowded clusters of catkins at the base of new shoots and are approximately ½ inch in length long. It is not uncommon to find a dominance of maleness or femaleness on individual trees.

Pollen generally matures in mid-May to mid-July. The time at which pollen matures appears to be related to elevation and climate.

Seed cones usually mature from August to October, more than a year after pollination. Inland forms and high elevation stands mature earlier than coastal forms or low elevation stands. Cones

open in early September in the Northern Rocky Mountains. Cone maturity is indicated by a change in color from purple-green to light brown.

Seed Production and Dissemination

Lodgepole pine produces viable seed at an early age, commonly 5 to 10 years; germination percentage is as high as that of seed borne by mature trees. Lodgepole pine is a prolific seed producer. Good crops can be expected on 1 to 3 year intervals, with light crops on intervening years. The cones withstand below freezing temperatures and are not generally affected by cone and seed feeding insects. Only squirrels and coreid bugs are significant seed predators.

Cone production can vary from a few hundred to a few thousand cones per tree. Cones are persistent and serotinous (closed) cones which can accumulate for decades. Annual production may run from 70,000 to 320,000 seeds per acre with half to one-third available for annual seed. Although the number of fully developed seeds per cone varies from as few as 1 to 2 to as many as 50, a normal average for large cone lots in the Rocky Mountains is from 10 to 24 seeds per cone.

Serotinous cones are common throughout Rocky Mountains region; however, this cone habit varies considerably over wide geographic regions as well as locally. Many stands in the Rockies have less than 50 percent serotinous-cone trees.

Lodgepole pine has long been regarded as a fire-maintained subclimax type. Its ability to regenerate in extremely dense stands to the exclusion of other species can be attributed to the closed cone habit. Millions of seeds per acre are held in reserve for many years and are readily available to germinate on the seedbed prepared by fire.

Serotinous cones do not open at maturity because of a resinous bond between the cone scales. The bonds break with temperatures between 113° to 140° F, and cone scales are then free to open. Large quantities of seeds are thus available for regenerating a stand following a fire. Closed cones at or near the soil surface (less than 12 inches) are also subjected to temperatures from insulation sufficient to open them and may provide seed in harvested areas. Some seeds may be damaged by high intensity, long duration fires.

Seeds stored in serotinous cones on the tree remain viable for years. Viability can be maintained so long as cones or seeds are not in contact with the ground. Once cones are on the ground, cones open. Damping-off fungi may infect the seed, rodents may feed on the seeds, or germination may occur; for the most part, seeds are not stored in the soil.

Lodgepole pine has relatively small seeds for a pine. Dispersal of sufficient seed to adequately restock an area often is only about 200 feet. Prevailing winds, thermal effects, or scudding on the snow may disperse seeds far beyond these distances.

The annual seed fall from nonserotinous cones helps in restocking relatively minor disturbances in the stand, in maintaining the presence of lodgepole pine in mixed stands, and in expanding conifers into other vegetative types. Most stands have some trees of the open-coned type. The

efficacy of this seed source can be seen in the dense stands of lodgepole pine along road cuts, power line rights-of-way, and ditches or where disturbance occurs near lodgepole pine stands.

Where large amounts of seed are stored in serotinous cones, a most effective means of seed dispersal in large openings is from cones attached to the slash and those knocked from the slash and scattered over the forest floor during slash disposal. Normal summer soil surface temperatures open many cones on or near the ground. In Montana, 83 percent of the cones on the ground opened the first year on south slopes compared to 40 percent on north slopes. Maximum seed release from serotinous cones near the ground takes place during the first year of exposure.

Seeds in unopened cones and those released from the slash may also be lost to rodents, fungi, and other destructive agents. Seeds from closed cones are usually available only for the first growing season following harvest, but stocking from open-cone seed sources can continue to increase for several years.

Slash disposal on areas where regeneration is planned from serotinous cones must be carefully planned and executed. Seed supply will be largely destroyed if slash to be burned is piled before cones have had a chance to open. Piling slash should be delayed until sufficient cones have opened to assure adequate stocking. Piling scatters seeds and opens cones, and helps prepare the seedbed. However, piling slash after germination can also decrease stocking because young seedlings are trampled or buried.

Broadcast burning will hasten the release of seeds from cones not in a position to open from high soil surface temperatures.

Seedling Development

Germination under field conditions is good if climate and seedbed are favorable. Best germination occurs in full sunlight and on bare mineral soil or disturbed duff, free of competing vegetation. Germination is epigeal. Temperatures' fluctuating between 47° and 78° F favor germination and adequate soil moisture is required for survival during the few weeks following germination. In Montana, 75 to 90 percent of total germination occurs during the 2 weeks following snowmelt, when the soil was saturated and temperatures were favorable. At optimum temperatures and moisture, almost 100 percent of the seeds germinate rapidly.

Both shading and competition inhibit germination and survival. Because residual overstory following partial cutting usually does not provide the most favorable conditions for regeneration, clearcutting is often recommended. In some areas, however, lodgepole pine has established itself in the shade of lightly cut or uneven-aged stands and may persist for many years in the understory. Some of these trees eventually may establish a crown sufficient to permit reasonable growth.

Drought is a common cause of mortality among first-year seedlings due to a relatively shallow root pattern. Losses vary with soil type and seedbed condition. Greatest losses occur on soils with low water-holding capacity and low duff and litter layers.

Young, succulent seedlings may die because of high soil surface temperatures. By 2 to 4 weeks of age, seedlings are able to withstand soil surface temperatures higher than140° F, which commonly occur at high elevation sites. Freezing temperatures may kill seedlings either directly or by frost heaving. In much of the range of lodgepole pine, however, frosts occur regularly throughout the growing season and seedlings from different sources vary in frost resistance.

Lodgepole pine seedlings are poor competitors and competition from grass is often most detrimental. The Douglas-fir/pinegrass habitat type is one of the most difficult sites for lodgepole pine regeneration, particularly if the regeneration effort is delayed until a firm sod cover is established.

Grazing animals, particularly cattle, can cause seedling mortality by trampling. Sheep actually seek the succulent new "candles" in the spring and nibble needles and small branches if other feed is not abundant.

A common problem of regenerating lodgepole pine stands is overstocking, which results in stagnation at early ages. Many sites are stocked with tens of thousands of trees per acre.

If trees are well distributed, stocking should not exceed 500 to 800 trees per acre at between 5 years and 20 years of age. Proper distribution and full utilization of the site, however, may require establishment of up to 1,000 stems per acre and thinning to obtain proper spacing.

An average height of 12 feet and DBH 2 inches on fully stocked 20-year-old stands was found on above average sites in Montana. Lodgepole pine height growth begins earlier than any of its associated species except for ponderosa pines and western larch on some sites.

Sapling and Pole Stages to Maturity

Because lodgepole pine has little taper and thin bark it produces a higher volume of wood for a given diameter and height than many of its associated species. Natural pruning is relatively poor, but limbs generally are of small diameter and lumber yields are good.

Growth and Yield

Growth and yield of lodgepole pine is greatly affected by stand density as well as by environmental factors.

Yields of about 12 to 16 MBF per acre can be found in old-growth Rocky Mountain lodgepole pine.

Mature sizes vary greatly between stands. In the Rocky Mountains, most trees at 140 years of age were 7 to 13 inches in diameter and about 60 to 80 feet in height.

Early management and control of stocking greatly affects growth and yield of lodgepole pine stands. Average annual growth in old-growth unmanaged stands in the central Rocky Mountains was about 25 to 40 board feet per acre because of large numbers of small trees and a high incidence of dwarf mistletoe. Annual net growth may be increased to 150 to 400 board feet per acre by controlling stand density.

Controlling stand density offers the greatest opportunity for increasing productivity of any readily available management practice.

Thinning of young overstocked and stagnating stands can restore growth potential and redirect it into merchantable-size products. Most of the yield increase possible from thinning is attained with the first entry.

Lodgepole pine shows good response to thinning at an early age. Heavily stocked stands must be thinned before stagnation occurs. The best age for thinning varies with site and density. Poor sites and overstocked stands particularly must be thinned as early as age 10.

Diameter growth acceleration is usually greatest in heavy thinnings; board foot volume and basal area growth are usually greatest in light thinnings.

At older ages, growth response is strongly correlated with crown size, vigor, and amount of release provided. Attempts at partial cutting of mature and over-mature stands have results in little gain and even negative net volume growth.

Lodgepole pine can be maintained best in a vigorous, productive forest by using a silvicultural method that regenerates even-aged stands. This often may be accomplished by clearcutting or patch cutting (1 to 5 acre clearcuts) and relying on natural regeneration. Planting can provide an opportunity to control initial stocking and improve the genetic diversity of the stand.

Rooting Habit

The root system of lodgepole pine varies considerably in form, depending on soil type. Root growth is particularly important during the critical first years. Root growth of 5 to 6 inches was reported for seedlings growing on prepared seedbeds in Montana. Seedlings growing near grass competition usually do not penetrate beyond about 2 inches.

Because of its shallow root system, lodgepole pine is susceptible to windfall, particularly stands which have been opened by harvesting. Windfirmness varies with stand density, soil conditions, and topography.

Reaction to Competition

Lodgepole pine is very intolerant of shade and competition from other plant species. In spite of its shade intolerance, lodgepole pine maintains itself in dense stands for long periods, often for 100 years or more.

In the absence of fire, lodgepole pine is usually succeeded by more shade tolerant species, such as Engelmann spruce, Douglas-fir and subalpine fir. Succession proceeds at variable rates and is particularly slow in high elevation forests.

Pure stands of lodgepole pine persist for varying lengths of time. In northern Idaho and central Oregon, stands begin to break up at 80 to 100 years, while stands at higher elevations, such as in Montana, southern Idaho, Utah, and Wyoming, last for several hundred years. Pure stands in and

around Yellowstone National Park contain 300 to 400 year-old trees, with several groups of younger even-aged trees.

The ability of lodgepole pine to regenerate at the expense of other species is due to cone serotiny, seed viability, germinative energy, early rapid growth, and ability to survive a wide variety of microsite and soil conditions.

Compared to its associated species, lodgepole pine is intermediate in its needs for water, requiring more than Douglas-fir and ponderosa pine and less than Engelmann spruce and subalpine fir. On some sites, lodgepole pine competes well for water and grows where other species may be excluded because of lack of water; on others it tolerates a high water tables. It is also intermediate in its tolerance to extremes of temperature.

Damaging Agents

The mountain pine beetle *(Dendroctonus ponderosae)* is the most severe insect pest of lodgepole pine. The epidemics that periodically occur in many lodgepole pine stands seriously affect the sustained yield and regulation of managed stands.

Adult beetles attack lodgepole pine in July or August, introducing bluestain fungi. The beetles lay eggs in the phloem where larvae feed and together with the fungi, girdle and kill the tree. Larvae overwinter in the tree, complete development, and emerge as adult beetles in the spring.

Harvesting has been considered as a means of preventing mountain pine beetle epidemics. Silvicultural practices such as thinning will control losses to mountain pine beetle and vigor in the stands.

The mountain pine beetle has played a historic role in the dynamics of lodgepole pine ecosystems. By periodically invading stands and creating large amounts of fuels, which are eventually consumed by fire, creating favorable conditions for regeneration, the beetle has increased the probability that lodgepole pine will reoccupy the site at the expense of other species.

Another aggressive bark beetle that attacks lodgepole pine is the pine engraver *(Ips pini).* Ips commonly develops in logging slash, especially slash that is shaded and does not dry quickly. Prompt slash disposal is an effective control measure. Ips also can build up in windthrows.

Other insects that can be damaging local pests are the lodgepole terminal weevil *(Pissodes terminalis),* which can be destructive to elongating terminal leaders; larvae of the Warren's collar weevil *(Hylobius warreni),* which girdles roots and the root collar; larvae of the weevil (*Magdalis gentiles),* which mine branches; various sucking insects, such as the pine needle scale *(Chionaspis pinifoliae),* the black pineleaf scale *(Nuculaspis californica),* and the spruce spider mite *(Oligonychus ununguis);* and several defoliating insects, among which are the lodgepole sawfly *(Neodiprion burkei),* the lodgepole needle miner *(Coleotechnites milleri),* the sugar pine tortrix *(Choristoneura lambertiana),* the pine tube moth *(Argyrotaenia pinatubana),* and the pandora moth *(Coloradia pandora).*

Dwarf mistletoe (particularly *Arceuthobium americanum) is* the most widespread and serious parasite affecting lodgepole pine. *A. americanum* seeds are forcibly ejected from the fruit for distances as great as 30 feet. The sticky seeds adhere to the foliage of potential host trees. Rate of spread in young stands is about 1.0 to 1.5 feet per year, with the fastest rate in dense stands. In many areas, more than 50 percent of lodgepole pine forests are infected. Dwarf mistletoe infection results in reduced diameter and height growth, increased mortality, reduced wood quality, decreased seed production, and overall decreased vigor.

Both harvesting and fire can greatly lessen the rate of spread and rates of infection. Effective control can be accomplished by clearcutting and locating boundaries of the unit to minimize reinfection from surrounding stands. Fire can effectively limit spread of dwarf mistletoe by eliminating sources of infection and establishing vast acreages of dwarf mistletoe-free areas.

Lodgepole pine is subject to attack by many fungal pathogens. These fungi are responsible for reduced growth and considerable cull and mortality. One of the most serious diseases in lodgepole pine is a stem canker caused by *Atropellis piniphila.* Cankered stems are usually useless for lumber or posts and poles. Stem cankers of rust fungi cause extensive mortality, growth loss, and cull in lodgepole pine. Of these comandra blister rust *(Cronartium comandrae)* is the most serious. The western gall rust *(Peridermium harknessii)* is especially damaging; trunk cankers can cause cull in logs and can kill seedlings and saplings. Because this rust does not require an alternate host, it can directly reinfect pines. Other fungi attack lodgepole pine and may cause serious losses in wood production. Examples are needle casts (such as *Elytroderma deformans* and *Lophodermella concolor);* root rots (such as *Armillaria mellea* and *Heterobasidion annosum);* and wood decays (such as *Phellinus pini* and *Peniophora pseudo-pini).*

Seed and seedling diseases are not usually damaging, although several mold fungi are associated with seed losses in germination and rotting and damping-off can affect young seedlings.

Mortality from beetle epidemics often creates large amounts of deadfall, which ignites easily from lightning and other sources and hampers fire control efforts.

Chinook winds following extremely cold weather occasionally cause red belt injury in Montana. Defoliation of trees is common and mortality can occur over large areas. Heavy snow can break or bend trees, particularly in dense stands with narrow crowns and intense root competition. Thinning can contribute to snow breakage, particularly if previously dense stands are opened suddenly.

Animals can cause considerable damage in thinned stands in some areas. Porcupines are attracted to thinned and fertilized stands in Montana. Pocket gophers often cover small seedlings under their entrance mounds and "winter-casts." They also feed on or clip both roots and tops. Gopher populations often explode as vegetation increases in open areas.

Special Uses

Lodgepole pine is not only an important timber species but is also a major tree cover in many scenic and recreational areas and on critical watersheds. It provides many acres of wildlife

habitat and is associated with many grazing allotments throughout its range. It is important to local communities throughout the West.
Lodgepole pine is used for framing, paneling, po
sts, corral poles, utility poles, railroad ties, and pulpwood. As new developments such as structural particleboard become practical, the rapid juvenile growth of the species will be an advantage where gross cubic foot volumes become important. Even now, with properly designed machinery, it is economically harvested, and this harvesting, properly done, can enhance watershed, forage, wildlife habitat, and scenic and recreational values.

Douglas-Fir

Douglas-fir (*Pseudotsuga menziesii*), also called red-fir, is one of the world's most important and valuable timber trees. It has been a major component of the forests of western North America since the mid-Pleistocene. The species has been successfully introduced in the last 100 years into many regions of the temperate forest zone. Two varieties of the species are recognized: *Pseudotsuga menziesii* (Mirb.) *var. menziesii*, called coast Douglas-fir, and *Pseudotsuga. menziesii var. glauca (Beissn.)*, called Rocky Mountain Douglas-fir.

Habitat

The latitudinal range of Douglas-fir is the greatest of any commercial conifer of western North America. Its native range extends from central British Columbia to southern reaches of the Pacific Coast Ranges and along the Rocky Mountains into the mountains of central Mexico. Nearly pure stands of Douglas-fir continue south from their northern limit on Vancouver Island to as far as the Santa Cruz Mountains. In the Sierra Nevada, Douglas-fir is a common part of the mixed conifer forest as far south as the Yosemite region. The range of Douglas-fir is fairly continuous through northern Idaho, western Montana, and northwestern Wyoming. Several outliers are present in Alberta and the eastern-central parts of Montana and Wyoming, the largest being in the Bighorn Mountains of Wyoming. In northeastern Oregon, and from southern Idaho south through the mountains of Utah, Nevada, Colorado, New Mexico, Arizona, extreme western Texas, and northern Mexico, the distribution becomes discontinuous.

Climate

Douglas-fir grows under a wide variety of climatic conditions. The coastal region of the Pacific Northwest has a maritime climate characterized by mild, wet winters and cool, relatively dry summers, a long frost-free season, and narrow diurnal fluctuations of temperature (43° to 46° F). Precipitation, mostly as rain, is concentrated in the winter months. Climate in the Cascade Range and Sierra Nevada tends to be more severe.

In the northern Rocky Mountains, Douglas-fir grows in a climate with a marked maritime influence. Mild continental climate prevails in all seasons, except midsummer. Precipitation is evenly distributed throughout the year, except for a dry period in July and August. In the central Rocky Mountains, the climate is continental. Winters are long and severe; summers are hot and in some parts of the region, very dry. Annual precipitation, higher on the western sides of the mountains, is mainly snow. Rainfall patterns for the southern Rocky Mountains generally show low winter precipitation east of the Continental Divide but high precipitation during the growing season. West of the Continental Divide, the rainfall is more evenly divided between winter and summer. Frost may occur in any month in the northern part of the range. Length of frost-free

periods, however, varies within the central and southern Rocky Mountain regions, even at the same elevations.

Soils and Topography

Soils within the range of Rocky Mountain Douglas-fir originated from a considerable array of parent materials. Parent materials in Montana consist of both igneous and sedimentary rocks, and locally of glacial moraines. Soils derived from noncalcareous substrates are variable in texture but consistently gravelly and acidic. A significant portion of the sedimentary rocks is limestone, which gives rise to neutral or alkaline soils ranging in texture from gravelly loams to gravelly silts. Limestone often weathers into soils that are excessively well drained. Soils are Cryoboralfs of the order Alfisols, and Cryandepts and Cryochrepts of the order Inceptisols.
Altitudinal distribution of both varieties of Douglas-fir (*menziesii and glauca*) increa
ses from north to south, reflecting the effect of climate on distribution of the species. The principal limiting factors are temperature in the north of the range and moisture in the south. Consequently, Douglas-fir is found mainly on southerly slopes in the northern part of its range, and on northerly exposures in the southern part.

Generally, the variety glauca grows at considerably high altitudes. In the central Rocky Mountains, Douglas-fir grows mostly at elevations between 6,000 and 8,000 feet.

Associated Forest Cover

Rocky Mountain Douglas-fir grows in extensive pure stands, uneven- and even-aged, in western Montana as a broad belt between ponderosa pine and spruce-fir zones. At high elevations, more cold-tolerant whitebark pine (*Pinus albicaulis*), true firs (*Abies* spp.), Engelmann spruce (*Picea engelmannii*) and lodgepole pine (*Pinus contorta*) gradually replace Douglas-fir.

Wherever Douglas-fir grows in mixture with other species, the proportion may vary greatly, depending on aspect, elevation, kind of soil, and the past history of an area, especially as it relates to fire. This is particularly true of the mixed conifer stands in the Rocky Mountains where Douglas-fir is associated with ponderosa pine, Engelmann spruce, and aspen (*Populus* spp.).

Principal understory species associated with variety glauca differ within its range. In Montana common snowberry (*Symphoricarpos albus*), white spirea (*Spirea betulifolia*) and ninebark (*Physocarpus malvaceus*) are common.

Flowering and Fruiting- Douglas-fir is monoecious; trees commonly begin to produce strobili at 12 to 15 years of age, although observations of younger seedlings bearing ovulate strobili have been reported.

Primordia of both pollen and seed cone buds are present when the vegetative bud breaks in the spring of the year before the cone crop. By September, the egg shaped pollen cone buds are easily distinguished from the darker vegetative buds and the larger seed cone buds.

The number of primordia that differentiate and develop into buds, not by the number formed, determines the size of the cone crop. Poor cone crops, then, reflect a high abortion rate of primordia the preceding year. Large numbers of pollen or seed cone buds in the fall merely

indicate the potential for a heavy cone crop the following year. Damaging frost during cone anthesis or depredations by insects may destroy most of the cones and seeds before they mature.

Male strobili are about 0.8 inches long and range from yellow to deep red. Female strobili are about 1.2 inches long and range from deep green to deep red. They have large trident bracts and are receptive to pollination soon after emergence.

Anthesis and pollination occurs during May or early June. Douglas-fir cones mature and seeds ripen in mid-August. Mature cones are 3 to 4 inches long. The bracts turn brown when seeds are mature. Seedfall occurs soon after cone maturity with two-thirds of the total crop on the ground by the end of October. The remaining seeds fall during winter and spring months.

Seed quality varies during the seedfall period. It is high in the fall but declines rapidly during winter and spring. This pattern probably reflects the fact that cone scales in the center of the cone, where the highest quality seed are borne, open early and scales at the tip and base of the cone, which bear generally poorly formed seeds, open late.

Both cones and seeds vary greatly in size. Size is determined before fertilization, so there is no correlation between weight of seed and genetic vigor, although seedlings germinated from heavier seeds may be slightly larger the first few months of growth than those grown from lighter seeds. Because the range in seed size from any one tree is relatively small, however, fractionation of seed lots to segregate the heavier seed may reduce the genetic variation and actually eliminate traits from certain populations.

Douglas-fir seed crops occur at irregular intervals- one heavy and one medium crop every 7 years on the average; however, even during heavy seed years, only about 25 percent of the trees produce an appreciable number of cones. Trees 200 to 300 years old produce the greatest number of cones.

Seed Production and Dissemination

Major deterrents to natural regeneration of Douglas-fir include limited seed supply; consumption of seed by insects, animals, and birds; competing plant species; and unfavorable environments. Although reports of fully stocked stands resulting from seedfall from sources 1/2 to 1 1/2 miles distant are not rare, the great majority of Douglas-fir seeds fall within 330 feet of a seed tree or stand edge.

Seedling Development

Douglas-fir germination is epigeal. Seed germinates in mid-May. Seedling growth the first year is relatively slow and limited generally by moisture, which triggers initiation of dormancy in midsummer. The dormant period normally extends from midsummer until April or May of the following year.

A duff layer, especially in the western larch forests of western Montana, favors seedlings of the variety glauca. First-year seedlings survive and grow best under light shade, especially on southern exposures, but older seedlings require full sunlight. Competition limits Douglas-fir regeneration.

Microsites with adverse moisture and temperature conditions frequently limit establishment of seedlings on southern aspects, especially limiting the distribution of glauca in the Rocky Mountains.

Douglas-fir is dependent on a mycorrhizal relationship for efficient uptake of mineral nutrients and water. Approximately 2,000 species of fungi have been identified as potential symbionts with Douglas-fir, and both ectomycorrhizal and ectendomycorrhizal structures have been observed on this species. Nursery specimen may have fewer mycorrhizae than they would in a natural setting.

Regeneration of variety glauca in the Rocky Mountains is variable. In general, glauca may be considered a seral species in moist habitats and a climax component in the warmer, drier areas. Regeneration is favored where Douglas-fir is seral. In contrast, regeneration of Douglas-fir is poor where the species has attained climax status.

Growth and Yield

The interior variety of Douglas-fir does not attain the growth rates, dimensions, or age of the coastal variety. Interior Douglas-fir reaches an average height of 60 to 120 feet with a DBH between 15 and 40 inches in 200 to 300 years. Diameter growth becomes extremely slow and height growth practically ceases after age 200.

Interior Douglas-fir is capable of response to release by accelerated diameter growth at any size or age. Gross volume yields for Douglas-fir in the northern Rocky Mountains are estimated for habitat types where Douglas-fir is climax range from about 80 to 200 MBF per acre per year to more than 400 MBF per acre per year in some of the more moist habitat types where Douglas-fir is seral.

Rooting Habit

Although Douglas-fir is potentially a deep-rooting species, its root morphology varies according to the nature of the soil. In the absence of obstructions, Douglas-fir initially forms a tap root that grows rapidly during the first few years. In deep soils (27 to 53 inches), it was found that tap roots grew to about 50 percent of their final depth in 3 to 5 years, and to 90 percent in 6 to 8 years; however, boulders or bedrock close to the soil surface result in quick proliferation of the original tap root. Platelike root systems develop when Douglas-fir grows in shallow soils or soils with a high water table. Main lateral branches develop during the first or second growing season as branches of the tap root. These structural roots tend to grow obliquely into deeper soil layers and contribute to anchoring a tree.

Size of the root system appears to be related to size of the crown rather than the bole. The radial symmetry of root systems seems to be readily distorted by slope, proximity to other trees, and presence of old roots

The proportion of root biomass decreases with age and may vary from 50 percent at age 21 to less than 20 percent in stands older than 100 years. Root grafting is very common in stands of Douglas-fir, often leading to a system of interconnected roots in older stands.

Reaction to Competition

Except in its youth, when it is reasonably tolerant of shade Douglas-fir is classed as intermediate in tolerance among its associates, being more tolerant than western larch, ponderosa pine, lodgepole pine and aspen. Douglas-fir is both a climax and a seral species in Montana. In northern Rocky Mountains, it replaces ponderosa pine, lodgepole pine, and western larch above the ponderosa pine belt, and in turn is replaced by Engelmann spruce and subalpine fir on cooler and wetter sites.

The natural occurrence of Douglas-fir in extensive stands is mainly a consequence of forest fires. The species' rapid growth and longevity, the thick corky bark of its lower boles and main roots, combined with its capacity to form adventitious roots, are the main adaptations that have enabled Douglas-fir to survive and to remain a dominant element in Montana's forests. Without fire or other drastic disturbance, Douglas-fir would gradually be replaced throughout much of its range by the spruce and true firs. Old-growth forests of Douglas-fir tend to show wide ranges in age structure-rather than being even-aged.

Stands of vigorous Douglas-fir can be successfully regenerated by any of the even-aged methods. Clear cutting in combination with planting is the most widely used method. In stands infected with dwarf mistletoe (*Arceuthobium* spp.), clearcutting is the best alternative for eliminating the disease. Because of its ability to tolerate shade in the seedling stage, the shelterwood system is a feasible alternative to clearcutting. Shelterwood harvest has been applied with good results. Where interior Douglas-fir is climax, the true selection method can be used.

Planting containerized seedlings is often the desired alternative method for regenerating Douglas-fir due to the lack of reliability of the seed crop.

When Douglas-fir develops in a closed stand, the lower limbs die rapidly. Natural pruning is exceedingly slow because even small dead limbs resist decay and persist for a very long period. On average, Douglas-fir is not clear to a height of 17 feet until 77 years old.

Seedlings and saplings of Douglas-fir respond satisfactorily to release from competing brush or overstory trees if they have not been suppressed too severely or too long. Trees of pole and small sawtimber size respond very well to thinning. Trees developed in a closed stand are adapt poorly to very heavy thinning. When exposed, the long slender boles with short crowns are highly susceptible to damage from snowbreak, windfall, and sunscald. Application of a nitrogen fertilizer in combination with thinning gives better growth responses in Douglas-fir than either fertilizer or thinning alone.

Damaging Agents

Douglas-fir is subject to serious damage from a variety of agents. Douglas-fir is host to hundreds of fungi, but relatively few of these cause serious problems. *Rhizina undulata*, shoestring root rot (*Armillaria mellea*), and laminated root rot (*Phellinus weirii*) can cause significant damage in plantations. The fungi represent a serious threat to management of young growth stands of Douglas-fir.

Trees die or are so weakened that they are blown over. Effective control measures are not available. Of the many heart rot fungi attacking Douglas-fir, the most damaging and widespread is red ring rot (*Phellinus pini*). Knots and scars resulting from fire, lightning, and falling trees are the main causes of infection. Losses from this heart rot far exceed those from any other decay.

The most damaging stem disease of Douglas-fir is *Arceuthobium douglasii*. This dwarf mistletoe occurs throughout most of the range of Douglas-fir. Over 60 species of insects are indigenous to Douglas-fir cones, but only a few species damage a significant proportion of the seed crop. Damage by insects is frequently more pronounced during the years of light or medium seed crops that may follow good or heavy crops.

The more destructive insects include: (a) the Douglas-fir seed chalcid (*Megastigmus spermotrophus*), which matures in the developing seed and gives no external sign of its presence; (b) the Douglas-fir cone moth (*Barbara colfaxiana*) and the fir cone worm (*Dioryctria abietivorella*) whose larvae bore through the developing cones and may leave external particles of frass; and (c) the Douglas-fir cone gall midge (*Contarinia oregonensis*) and cone scale midge (*C. washingtonensis*), which destroy some seed but prevent harvest of many more by causing galls that prevent normal opening of cones. The Douglas-fir cone moth is perhaps a more serious pest in the drier, interior portions of the Douglas-fir range and the *Contarinia* spp. in the wetter regions. Any of these insects, however, may effectively destroy a cone crop in a given location.

The Douglas-fir tussock moth (*Orgyia pseudotsugata*) and the western spruce budworm (*Choristoneura fumiferana*) are the most important insect enemies of Douglas-fir. Both insects attack trees of all ages at periodic intervals throughout the range of interior Douglas-fir, often resulting in severe defoliation of stands. The Douglas-fir beetle (*Dendroctonus pseudotsugae*) is a destructive insect pest in old-growth stands. Its impact is diminishing, however, with the change to second-growth management and rotations of less than 100 years.

Consumption of Douglas-fir seeds by small forest mammals such as white-footed deer mice, creeping voles, chipmunks, and shrews, and birds such as juncos, varied thrush, blue and ruffed grouse, and song sparrows further reduces seed quantity. A single deer mouse may devour 350 Douglas-fir seeds in a single night.

Browsing and clipping by hares, brush rabbits, mountain beaver, pocket gophers, deer, and elk often injure seedlings and saplings. In drier areas, domestic livestock have caused considerable damage to plantations by grazing and trampling seedlings. In pole-sized timber, bears sometimes deform and even kill young trees by stripping off the bark and cambium.

High winds following heavy rains occasionally cause heavy losses from blowdown in the west. Heavy snow and ice storms periodically break the tops of scattered trees in dense young stands. Crown fires destroy stands of all ages. The thick bark of older Douglas-firs, makes them fairly resistant to ground fires.

Special Uses

Douglas-fir is grown as a Christmas tree on rotations ranging from 4 to 7 years. Trees are sheared each year to obtain a pyramid-shaped crown.

Western Larch

Western larch (*Larix occidentalis*), a deciduous conifer, is also called tamarack and western tamarack. It is the largest of the larches and is the most important timber species of the genus. Western larch is used for lumber, fine veneer, poles, ties, mine timbers, and pulpwood.

Habitat

Western larch grows in the Upper Columbia River Basin of western Montana, northern and west central Idaho, northeastern Washington, and southeastern British Columbia; along the east slopes of the Cascade Mountains in Washington and north-central Oregon; and in the Blue and Wallowa Mountains of southeastern Washington and northeastern Oregon.

Climate

Western larch grows in a relatively moist-cool climatic zone, with low temperature limiting its upper elevational range and deficient moistures its lower extremes. Mean annual temperature within the larch zone is about 45° F, but annual maximums average 84° F and minimums average 15° F. Average temperatures during the May through August growing season are about 60° F with July being the warmest month. The frost-free season varies from about 60 to 160 days, usually from early June through early September. Frosts can occur any month of the year.

Annual precipitation in western larch forests averages about 28 inches in the north part of its range to 32 inches in the south. The extremes where western larch grows are about 18 inches in central Montana to 50 inches. About one-fifteenth of the annual precipitation occurs during the May through August growing season, most of that is in May and June. July and August are usually dry and are characterized by clear, sunny days (60 to 80 percent of the daylight hours), low humidity, and high evaporation rates. Elevation and geographic location affect both the amount and the form of precipitation. On mid-elevation sites, snow commonly blankets most larch forests from November to late April and accounts for over half the total precipitation. Snow accounts for an even higher proportion of the total precipitation in the northerly higher elevation portions of western larch forests. One high elevation western larch site at Roland, Idaho, receives an average of 244 inches of snow annually. Lower elevation sites commonly receive an average of more than 60 inches of snow.

Soils and Topography

Western larch grows on a wide variety of soils. The most extensive soils have developed in glacial till or colluvium composed of materials derived from limestone, argillite, and quartzite bedrocks of the Precambrian belt geologic series. Western larch also grows on soils developed in Recent and Tertiary alluvium and Pleistocene lake sediments. Most soils suitable for the growth of western larch are deep and well drained. Soils developed in glacial till, colluvium, and recent alluvium have non-gravelly to gravelly loamy surfaces and gravelly to extremely gravelly loamy subsoils. Volcanic ash is often incorporated into the surface horizon. Soils developed in Tertiary sediments or Pleistocene lake sediments have silt loam surfaces and silt loam, silty clay loam, silty clay, or clay subsoils.

Most soils supporting the growth of western larch are classified in two orders of the soil taxonomy: Inceptisols and Alfisols. Occasionally western larch is found on soils of the order

Spodosols, but Spodosols are not extensive within the range of western larch and generally occur above the upper elevational limits of the species. A majority of the soils supporting the growth of western larch are the Cryoboralf, Cryochrept, and Cryandept great groups. Mean annual soil temperature of the soils within the great groups is about 41° F at 20 inches. At low elevations on southern or western exposures within the range of western larch, soil temperatures are warmer and soils supporting the growth of western larch are in the Eutroboralf and Eutrochrept great soil groups.

Western larch grows best on the more moist Eutrochrepts or Eutroboralfs and the lower elevation (warmer) Cryochrepts and Cryoboralfs. It is commonly found growing on valley bottoms, benches, and north- and east-facing mountain slopes. South and west exposures are often too severe for larch seedling establishment, particularly on the drier sites found at western larch's lower elevational limits and the southern portion of its range. On moist sites found in the mid-to northern-portion of its range and on mid- to high-elevation sites, western larch grows on all exposures.

Associated Forest Cover

Western larch is a long-lived seral species that always grows with other tree species. Young stands sometimes appear to be pure, but other species are in the understory, Douglas-fir (*Pseudotsuga menziesii var. glauca*) is its most common tree associate. Other common tree associates include: ponderosa pine (*Pinus ponderosa*) on the lower, drier sites; and Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*) in the cool-moist subalpine forests.

In Montana, western larch is a significant component in about 1/3 of the forest habitat types. Of these habitat types, western larch is a major seral species in 1/2, and a minor seral species in the other 1/2. These habitat types are found within the following forest series: the relatively dry-warm Douglas-fir; the moist grand fir, western redcedar, and western hemlock; and the cold-moist subalpine fir.

Western larch forests typically have a rich understory flora with dense herbaceous and less dense shrub layers. It is not unusual to find as many as 7 tree species and 40 undergrowth species on plots

Life History

Reproduction and Early Growth

Western larch is monoecious; both staminate and ovulate flowers develop throughout the crown. Buds are found at the end of short spurlike lateral branchlets. Vegetative buds are smaller than flower buds-usually about 0.10 to 0.12 inches in diameter, whereas flower buds range from about 0.12 to 0.19 inches in diameter. Ovulate buds are one to one and one-half times longer than they are wide and are rounded or conical on the end. Staminate buds are usually globose and about one and one-half to two times longer than wide. Vegetative and flower buds can be detected early in the fall, about 1 year before subsequent cone crops mature. Methods of sampling buds and conelets have been devised for forecasting larch seed crops on individual trees, as well as stands.

Pollen and seed conelets appear several days before vegetative buds open-usually from about April 15 to May 15. Conelets are generally very conspicuous, varying from bright red to green. Pollination occurs in late May and early June. Cones complete their development in one season and mature by mid- to late-August, reaching 1.0 to 1.8 inches in length.

Cones usually begin to open by early September, but in cool-moist summers cone opening may be delayed a month or longer. More than 80 percent of the seeds usually are dispersed by mid-October. Cones open when they have dried to a moisture content of 35 to 40 percent, opening at the same time on individual trees, but varying substantially among trees in the same stand. Cones usually fall from the tree during the following winter, but many may stay attached through the next summer.

Seed Production and Dissemination
Western larch is a good seed producer, but cone crops vary substantially by year and location. Long-term records of western larch seed production in Montana show that good seed crops are produced at about 5-year intervals with fair to poor crops in the intervening years. Two good crops or several poor crops, however, may occur in close succession. Overall, the ratio of good or fair to poor seed crop is about 1 to 1.

Cone production is infrequent on larch trees less than 25 years old, although trees as young as 8 years occasionally produce cones. Larch starts bearing abundant cone crops from 40 to 50 years and continues bearing heavily for 300 to 500 years.

Cone production usually is a function of crown size because larch bears cones throughout the crown. Trees with the largest crowns produce the most cones. During a good cone year, production ranged from a low of 56 cones in one tree with 45 major branches to a high of 2,090 cones in another tree with 95 major branches. Also, vigorous, full-crowned, mature trees averaging 22 inches in diameter produced about five times as many seeds as 14-inch trees in the same stand and age class.

A mature cone may have as many as 80 filled seeds per cone, but the average is about half that number. Seed viability is related to cone-crop size, ranging from a low of 5 to 10 percent viability in poor crops to 70 to 80 percent in good crops. Young trees usually produce seeds of higher viability than over-mature trees.

Western larch seeds are small and lightweight, averaging 137,000 seeds per pound. Because of their relatively large wing, they are dispersed to greater distances than the heavier seeds of Douglas-fir and subalpine fir, but to about the same distance as the light seed of Engelmann spruce. Western larch seed may be dispersed 787 feet from clear-cut boundaries under normal wind conditions. Although the seeds traveling that distance are only about 5 percent of that falling within the timber, they may amount to 40,000 seeds per acre in a heavy seed year-more than is adequate to restock favorable seedbeds.

Overstocking often occurs near the seed source when bare soil is exposed. Seeds are disseminated more uniformly in seed tree and shelterwood cuts than in clearcuts.

Seed production in mature natural stands of western larch may exceed 0.5 million seeds per acre in a heavy seed crop. Small rodents eat only about 1 to 3 percent of the seeds during the over-wintering period. In contrast, rodents usually feed heavily on the larger seeds of Douglas-fir and ponderosa pine during this same period.

Western larch seed germinates about the time of snowmelt from late April to early June, usually 1 to 2 weeks before associated tree species. Germination is epigeal. Natural stratification of western larch seeds during the winter prompts rapid and complete germination. Without stratification, spring-sown western larch seeds germinate slowly and erratically, with some seeds holding over until the next season. Artificial stratification methods using cold-moist conditions work well for preparing seed for field germination. Air temperatures of about 80° F are ideal for western larch seed germination.

Seedling Development

Western larch is a seral species well adapted to seedbeds exposed by burning or mechanical scarification. Seedbeds of undisturbed litter, humus, sod, and areas with heavy root competition are poor for western larch seedling survival. Most seedling losses occurred the first growing season- after 3 years, seedling losses are minor.

Seedling survival is affected mostly by biotic factors early in the growing season and by physical factors late in the season. Until about mid-July, mortality is caused primarily by fungi, rodents, birds, and insects. Most losses of first-year seedlings, particularly those growing on duff, are caused by fungi, usually immediately after germination. Seedlings growing on mineral soil seedbeds are far less susceptible to fungi than their counterparts growing on duff under both full sun and partial shade. Under full shade, however, susceptibility of the two types of seedbed is reversed. Seedling losses to animals, insects, and birds are relatively minor overall but may be heavy in specific locations and years.

Insulation is the most important physical factor affecting western larch seedling survival. High soil surface temperatures exceeding 135° F are not uncommon starting in late June, resulting in heat girdling of seedlings at the soil-air interface. Duff is the least desirable seedbed, with lethal temperatures occurring earlier in the season and on more days. Lethal soil temperatures are reached most frequently on duff, less on burned mineral soil, and least on scarified mineral soil. On south and west slopes, soil surface temperatures exceed 175° F, and few western larch seedlings survive regardless of the type of seedbed.

Drought is the major physical factor affecting mid-to late-season seedling survival. Unlike insulation, drought losses are heaviest in full shade because of the heavy competition for moisture by all vegetation.

Although aspect affects germination very little, it has a pronounced effect on seedling survival. North, northwest, and northeast exposures and gentle to flat topography provide the most favorable conditions for western larch seedling survival. High surface temperatures and droughty conditions on the south and west exposures preclude survival of any significant number of western larch seedlings. As a result, western larch is either absent or but a minor stand component on hot, dry slopes.

Western larch seedlings grow about 2 inches the first growing season. In shade, root penetration may average only 1 inch the first year, while its counterparts growing in the sun or partial shade may have 9 inch roots. Seedlings growing in partial shade usually grow faster in height than seedlings in full sunlight for the first few years, but faster in full sunlight after that.

Western larch seedlings break dormancy very easily. Buds usually burst by late April, well before those of any other native conifers. Shoot growth starts from late May to mid-June.

Western larch seedlings grow rapidly in spite of the relatively short growing season of the Rockies. Average annual height growth of about 12 inches occurs for the first 4 years. Only lodgepole pine matches the rapid juvenile height growth of western larch. Douglas-fir seedlings grow at about one-half the rate of western larch, and Engelmann spruce and subalpine fir seedlings grow at about one-fourth the rate of western larch.

Growth and Yield

Western larch is long-lived and is the largest of the world larches. Trees exceeding 90 inches in diameter and 900 years of age have been found. Larch normally reaches 100 to 180 feet in height at maturity and occasionally exceeds 200 feet.

Western larch grows faster in height than any other conifer in the Rocky Mountains for the first century, giving this highly shade-intolerant species the height advantage it needs to survive. For the first 50 years, larch and lodgepole pine height growth are similar, but thereafter lodgepole height growth declines in comparison with larch.

Site productivity accounts for the largest share of the variation in height growth of larch throughout its range. Site index curves for western larch (base age of 50) show heights at age 100 ranging from 65 feet on low sites to 130 feet on high sites.

Seedbed conditions at the time of seedling establishment influence height growth in the formative years. These differences may be due to changes in nutrient availability, water infiltration into the soil, or competing vegetation.

Stand density also affects height growth very early in the life of the stand. Heavy overstocking is common in young stands with densities sometimes exceeding 35,000 trees per acre. Thinning these overstocked stands relieved this height growth suppression. By age 24, dominant trees in the thinned stands averaged more than 30 feet tall, but their counterparts in the unthinned stands averaged 15 to 20 percent less.

Diameter growth measured at breast height for larch largely parallels height growth and is affected by many of the same factors. Larch has the potential for rapid diameter growth, but overstocking, insects, and dwarf mistletoe often prevent full realization of this potential.

Larch diameter growth is very sensitive to stand density. Thirty to 50-year-old stands in Montana showed crop-trees in unthinned stands growing at about half their potential.

Basal area increases rapidly to about age 40 years, decelerates, and nearly levels off after age 100. At age 100, basal area of larch forests approaches 300 feet²/acre on high quality sites and about 200 feet²/acre on low quality sites. On high sites, the average annual increase in basal area is about 3 feet²/acre for the first century.

Larch forests can produce heavy timber volumes. The increase in volume follows a similar pattern as basal area but peaks later. Because of their influence on diameter and height growth, site quality, age, and stocking level play the major roles in volume yield. Projected yields for larch forests at age 100 range from 4,407 feet³/acre on low quality to 11,608 feet³/acre on high quality sites. With full stocking (but not overstocked), 7,765 feet³/acre is a reasonable objective by age 100 on medium quality sites for larch forests.

Rooting Habit

Western larch develops a deep and extensive root system. Root lengths on first-year natural seedlings usually reach 2 inches. Observations in soils under young western larch stands indicate extensive fibrous rooting in the top 20 inches, substantially less in the 20-40 inch depths, and practically none at greater depths. Heavy rooting at depths greater than the above has been observed along roadcuts through old-growth stands. Evaluations of roots of windfallen over-mature western larch show that nearly all of them were infected with root rots. These rots play an important role in wind stability of over-mature trees.

Reaction to Competition

Western larch is the most shade-intolerant conifer in the Northern Rockies. Only during the seedling stage can it tolerate partial shading. If western larch is overtopped, its crown rapidly deteriorates, and its vigor declines severely.

Because of its intolerance to shade, western larch grows in even-aged stands or age-classes. Its primary associates are usually the same age as western larch but often give the appearance of being younger because they grow slower than western larch and form the lower strata in the stand. As western larch stands mature, however, shade-tolerant associates continue to establish and form younger under-stories.

Fire is essential to the maintenance of western larch in natural forest stands. Most fires that occur on mountain slopes are usually small and of low or moderate intensity. Fire intensity, however, increases on steep slopes with heavy fuels, or on dry ridgetops. These fires thin stands, reduce fuels, rejuvenate undergrowth, and prepare seedbeds that promote mixed conifer stands with small pockets of regeneration dominated by seral species, particularly western larch. Intense fires often create definite even-aged stands. In these stands, all species can stagnate unless periodic fires release some trees. Without fire, Douglas-fir will replace the seral species.

Although western larch normally remains in the dominant position, understory trees and other vegetation vigorously compete with western larch for available water and nutrients. In one harvest-cutting study, diameter growth of residual mature seed trees after logging increased 67 percent over pre-logging growth. When all understory trees were also cut, the seed trees increased an additional 36 percent in diameter increment.

Even-aged silviculture systems of shelterwoods, seed-tree cuttings, and clear-cuts best fit the ecological requirements of western larch forests. They provide an adequate seed source and the microsite conditions needed for establishing the new seedlings. These systems are also compatible with the site preparations of prescribed burning or scarification needed to reduce the duff layers and vegetative competition for the new seedlings. Prescribed burning most closely approximates the natural wildfires that historically have perpetuated western larch forests. No detrimental impact on site quality has been attributed to harvesting or prescribed fire on the soil microflora.

Conversely, uneven-aged silviculture systems have limited utility in most western larch forests. Not only does the residual stand show little overall growth response after partial cuttings, the growth increases that do occur are mainly on the more tolerant and generally less desirable species, such as subalpine fir. In addition, partial cuttings discriminate strongly against western larch and its shade-intolerant associates in the regeneration process, and western larch becomes a minor stand component in stands it formerly dominated. Prescribed burning or scarification needed to regenerate western larch, are very difficult in partial cuttings. For management considerations other than timber production, such as esthetics or wildlife, there may be rationale for uneven-aged silviculture systems in some western larch forests. Even then, however, it should be recognized that these practices violate the normal regeneration sequence in most of these forests, accelerate the succession to tolerant species, and increase insect and disease problems.

Thinning in young western larch stands, preferably before age 20, enhances the growth of diameter and height during the juvenile years when response potential is greatest. Drastic reduction in the densities found in most unthinned stands is advisable. Studies in young western larch show that western larch responds well in diameter, height, and crown retention under a fairly broad range of densities after thinning, usually exceeding what were thought to be maximum growth rates. Even at ages 30 to 50, western larch responds well to release. By this age, however, overstocking has reduced the crown and response is usually delayed. Timing and extent of response is a function of length and severity of overstocking. Individual tree growth once lost can never be regained.

Preliminary studies of fertilization in Montana show a positive diameter growth response to fertilization with nitrogen, but the effects last only about 3 years. Similar studies in Idaho showed a short-term diameter growth response to nitrogen, but neither study showed any height increase.

Damaging Agents

Mature western larches are the most fire-resistant trees in the Northern Rockies because of their thick bark, their high and open branching habit, and the low flammability of their foliage. Poles are moderately resistant, but seedlings and saplings have very little resistance to fire.

Western larch is moderately to highly resistant to windthrow because of its extensive root system. Isolated old-growth seed trees or those along cutting boundaries, however, are susceptible to windthrow, particularly those on upper slopes and ridgetops, or those in narrow canyons and saddles where winds are channeled.

Because western larch is deciduous, its branches seldom accumulate excessive amounts of either snow or ice. Early or late snows occasionally catch western larch with a full complement of needles and cause severe bending.

Dwarf mistletoe (*Arceuthobium laricis*) is the most damaging disease-causing parasite of western larch. It can infect seedlings as young as 3 to 7 years old and continue throughout the life of the tree. In addition to killing tree tops, reducing seed viability, creating conditions suitable for entry of other diseases and insects, and causing burls, brashness, and some mortality, it decreases height and diameter growth.

Infected overstories left after logging or fires promptly infect understory stands. Mistletoe seed can be ejected as far as 45 feet. Thus 20 evenly-spaced, diseased trees per acre may infest understory trees with just one crop of mistletoe seeds. Proper harvest-cutting systems, particularly clear-cutting, can substantially reduce the mistletoe problem.

Three other important diseases are found in western larch: needlecast caused by *Hypodermella laricis*, the quinine fungus *Fomitopsis officinalis*, and red ring rot caused by *Phellinus pini*. Many other less common but potentially dangerous fungi, such as *Encoeliopsis laricina*, infect western larch but have not caused significant problems.

Western larch casebearer (*Coleophora laricella*) and western spruce budworm (*Choristoneura occidentalis*) are two of the most serious insect pests of western larch. Casebearer was first detected in the Northern Rockies in 1957 and since then has spread throughout virtually the entire western larch forest type. Introduced and native parasites, plus adverse weather conditions on many western larch sites, appear to be reducing the casebearer problem. Severe defoliation by the casebearer can substantially reduce tree growth, but mortality usually is low.

Western spruce budworm has been a persistent problem wherever heavy populations of budworm overlap the range of western larch. The most serious damage to western larch is severance of the terminal leader, which results in an average loss of about 25 to 30 percent of the height growth for that year.

Special Uses

Western larch forests are valued for their multiple resource values. The seasonal change in hue of western larch's delicate foliage from light green in the spring and summer, to gold in the fall, enhances the beauty of these mountain forests.

Because western larch is an aggressive pioneer species, it quickly reforests areas denuded by natural or man-caused disturbances, providing protection for those important watersheds. Western larch is an important component of high water-yielding forests areas where management can influence water yield through harvest cuttings and young stand culture.

Western larch forests provide the ecological niches needed for a wide variety of birds and animals. Hole-nesting birds comprise about one-fourth of the bird species in these forests. Deer,

elk, moose, and the black and grizzly bear are widespread and numerous throughout the range of western larch.

Western larch timber is used extensively for lumber, fine veneer, long-straight utility poles, railroad ties, mine timbers, and pulpwood. Western larch wood is strong and hard and contains about 4 to 23 percent arabinogalactan. It is the best domestic source of this water soluble gum used for offset lithography and in food, pharmaceutical, paint, ink, and other industries. Arabinogalactan has the consistency of honey and contains 16 percent volatile pinene and limonene.

Timber harvesting practices in western larch forests are now utilizing more of the woody biomass formerly left in the woods after logging. Typically, large volumes of standing live and dead tree biomass are found in old-growth western larch forests.

Ponderosa Pine

Ponderosa pine, also known as yellow pine and bull pine, is one of the most widely distributed pine trees in western North America. A major source of timber, ponderosa pine forests are also important as wildlife habitat, for recreational use and for aesthetic values. Within its extensive range, two varieties of the species currently are recognized: Pinus ponderosa var. ponderosa (Pacific ponderosa pine) (typical) and var. scopulorum (Rocky Mountain ponderosa pine). Pacific ponderosa pine is not relevant for the Garlick property properties and will not be discussed in detail in this plan.

Habitat

The range of ponderosa pine extends from southern Canada into Mexico and from the Plains States of Nebraska and Oklahoma to the Pacific Coast. Rocky Mountain ponderosa pine (*var. scopulorum*) extends east of the Continental Divide from latitude 48° N. in north-central Montana, southeasterly into North and South Dakota, eastern Wyoming, and as far east as north-central Nebraska. Within this area, ponderosa pine grows on the discontinuous mountains, plateaus, canyons and breaks of the plains, with the extensive stands found in the Black Hills of South Dakota and Wyoming. South of Wyoming, Rocky Mountain ponderosa pine extends south on both sides of the Continental Divide, west to Arizona and the eastern edge of the Great Basin in Nevada, and east to Texas west of the Pecos River, New Mexico, extreme northwestern Oklahoma, Colorado, and northern Mexico. Within this wide range, ponderosa pine is absent from a large area, including southwestern Montana, western Wyoming, southern Idaho and part of the Great Basin. Decreased moisture and shorter growing seasons may attribute to these pockets.

Climate

Moisture is the limiting factor that influences the growth and mortality of ponderosa pine. This is especially true in areas where summer rainfall is limited. In Montana, east of the Continental Divide, average annual precipitation in ponderosa pine forests ranges from 11 to 17 inches, with 5 to 10 inches received during the May-to-August period. In some places, July and August precipitation is often lacking. Except on coarse-textured soils, summer showers probably provide scant moisture useful to young seedlings.

Regardless of the location where ponderosa pine grows, average annual temperatures are between 41° and 50° F and average July-August temperatures are between 62° and 70° F. Average frost-free seasons for ponderosa pine range from 90 to 154 days in eastern Montana. Annual extremes are from -40° to 110° F.

Soils and Topography

Ponderosa pine grows on soils derived from igneous, metamorphic and sedimentary parent materials, including quartzite, argillite, schist, shale, basalt, andesite, granite, cinders, pumice, limestone and sandstone. This results in a variety of soil orders including Entisols, Inceptisols, Mollisols, Alfisols, and Ultisols on which the species is found throughout its extensive range.

Its distribution on drier sites is related closely to supplies of available soil moisture which in turn are related to soil textures and depth. Ponderosa pine stands in Montana grow best in medium-textured soils and least in fine-textured soils. Root concentration is more uniform in the medium-textured soils and poor at depths over 18 inches in fine-textured soils. Depending on the locality and the horizon of the samples, soils vary from pH 4.9 to pH 9.1. The pH in the surface horizon is frequently from 6.0 to 7.0.

Foliar concentrations of nitrogen and phosphorus needed for adequate growth are low in ponderosa pine compared with the associated conifers. There is a fine line between nutrient deficiency and sufficiency in ponderosa pine. Correcting nitrogen deficiency in California and central Oregon stands has increased volume growth 30 percent. Because of this, ponderosa pine is judged to be superior in satisfying its nutritional needs on soils that by other species' standards are infertile.

Ponderosa pine is found at elevations from sea level to 10,000 feet. From north to south, the species grows at progressively higher altitudes and within more restricted elevational limits.

Associated Forest Cover

Ponderosa pine can be either a climax or a seral species. It is a climax species at the lower limits of the coniferous forests, and a seral species in higher elevation mesic forests where more competitive conifers are capable of growing. In climax forests, ponderosa pine stands often contain many small, even-aged groups rather than a true uneven-aged structure.

Fires have had a profound effect on the distribution of ponderosa pine. Although the seedlings are readily killed by fire, larger trees possess thick bark, offering effective protection from fire damage. Competing tree species, such as the true firs and Douglas-fir, are considerably less fire-tolerant, especially in the sapling and pole size classes.

Due to successful fire control over the past 90 years, many of these stands have developed understories of Douglas-fir and subalpine fir. Type conversion has been accelerated by harvest of the ponderosa pine, leaving residual stands composed of subalpine fir, Douglas-fir or lodgepole pine. In the Pacific Northwest, forest cover types on about 5 million acres are believed to have changed in the last 25 years.

Ponderosa pine is an integral component of three forest cover types in the West: Interior Ponderosa Pine, Pacific Ponderosa Pine-Douglas-Fir and Pacific Ponderosa Pine. Interior Ponderosa Pine is the most widespread type, covering most of the range of the species from Canada to Mexico, from the Plains States to the Sierra Nevada, and to the east side of the Cascade Mountains. Ponderosa pine is also a component of 65% of all western forest cover types south of the boreal forest.

There is ample evidence indicating that ponderosa pine forests had stand replacing fires in pre-settlement conditions, suggesting that ponderosa pine forests were never homogeneous open park-like stands across all of their territory.

Life History:

Reproduction and Early Growth

Ponderosa pine is monoecious. At pollination the male strobili, borne in short, dense clusters, are 0.8 to 1.2 inches long and female conelets are 1 inch long. In western Montana, central Idaho and eastern Oregon, at elevations from 3,000 to 6,000 feet, flowering generally begins between May 1 and 10. Pollen is shed May 25 to June 15, cones reach a full size of 3 to 6 inches by July 20 to August 10 of the next year, seed is ripe August 20 to September 5, cones begin to open September 1 to 13, and seed is shed until November.

Seed Production and Dissemination

No regular periodicity has been observed in the seed production of ponderosa pine over its entire range. Observations in Montana show ponderosa pine to be a poor seeder west of the Continental Divide, and a fair seeder east of the Continental Divide, with only one good crop every few years. The species bears cones as early as 7 years and continues to produce good seeds to at least 350 years. Seeds from trees aged 60 to 160, however, are more viable than those of younger or older trees.

In eastern Washington, Idaho and Montana, 16 species of insects have been identified as causing seed losses in ponderosa pine. They destroy up to 95% of the cone crop in some areas and ranging from 30 to 60 %. The proportion of seeds lost to insects is usually highest when crops are small. Ponderosa pine seeds are consumed by many birds and small mammals such as mice, chipmunks and tree squirrels. In years of low cone production, the potential seed crop may be severely reduced. Squirrels clip many of the cone bearing twigs, destroying flowers and conelets. Ponderosa pine seeds are not disseminated naturally over extensive distances. In central Oregon, seedfall at 120 feet was only 22% of the seedfall at the west edge of a cleared area, and at 396 feet it was only 8%. Nearly all seeds are disseminated by early November. In a good year as many as 345,080 seeds per acre reach the ground.

Seedling Development

Natural regeneration is sporadic. Successful natural regeneration is thought to be a combination of a heavy seed crop and favorable weather during the next growing season. Soil texture, plant competition, and seedbed conditions are other common determinants of survival of young seedlings. Moisture stress reduces seed germination as well as initial seedling survival and growth. Older seedlings, however, are able to cope with limited moisture supplies by reducing

transpiration and by vigorously extending their root systems. Transpiration rate declines at lower soil water potentials. Ponderosa pine has the capacity for root growth in relatively dry soil.

The significance of competing vegetation as a deterrent to early survival and development of young seedlings has been clearly demonstrated. In central Idaho, soil moisture remained above the wilting point at depths below 6 inches on areas free of competing vegetation throughout the growing season but dropped to or below that critical point on most vegetated plots. In loamy soils, drought is normally not a major variable in seedling survival beyond age 2, except where there is heavy grass cover. Shrub competition will reduce the height and diameter growth of ponderosa pine.

Air and soil temperatures often affect growth. Seedling root growth is best at 59° F air temperature and 73° F soil temperature. Height growth is greatest at 73° F temperature for air and soil.

Height growth of ponderosa pine starts significantly later with each increase of 2,000 feet in elevation, and the length of the growing season is significantly shorter with each 3,000 feet increase in elevation. Rates of height and radial growth did not vary with an increase in elevation during the period of growth. Ponderosa pine starts height growth before many species but not before lodgepole pine.

Many variables cause seedling mortality. Ponderosa pine seedlings less than 36 days old are more susceptible to minimum night temperatures (lower than 23° F) than some species. During winters with little snow cover, 1 and 2 year old seedlings suffer damage and/or death from frost. Natural regeneration on fine-textured soils can be almost non-existent because of frost-heaving. Ordinarily, older seedlings are hardy in severe winter temperatures, but occasionally suffer "winter killing" of foliage (a desiccation process) if the temperature drops suddenly when drying winds and frozen ground are present. Also, 1 to 3 month old seedlings are killed by stem temperatures of about 130° F and higher. Ponderosa pine is more successful in resisting high soil surface temperature with increasing age than other species like Douglas-fir and Engelmann spruce.

Growth and Yield

Ponderosa pine grows to impressive size: stems of 103.5 inches at DBH and up to 232 feet in height have been recorded. Diameters at breast height of 30 to 50 inches and heights of 60 to 130 feet are common throughout most of its range. Trees can reach ages of 300 to 600 years.

Diameter growth can be rapid and remain fairly constant for long periods provided trees are given adequate growing space. On less productive ground, trees 5 to 20 inches in DBH and from 19 to 36 years old can grow 5 inches in diameter per decade if free of tree competition. Vegetative competition can markedly restrict diameter growth whether from neighboring trees or understory shrubs. Trees completely surrounded by understory shrubs can grow as little as 3.5 inches in a 10-year period. Sites with droughty, skeletal soils and severe shrub competition will have a reduction in diameter growth to less than half that of competition-free trees. Insect damage, which is greater for trees competing with shrubs, accounts for some of the growth

depression. Densely stocked stands throughout the species' range are a serious problem, causing stagnation of stem diameter and height.

Height growth is most rapid in the pole and young sawtimber size classes to about 60 years, after which it gradually declines. Dominant trees in stands of moderate density grow from 0.8 to 1.5 feet annually between the ages of 20 to 60 years on good timber producing sites. Height growth increases with site productivity and inversely with stocking rates or stand density.

Old-growth ponderosa pine produces clear, high-grade lumber, but young trees typically are limby; natural pruning develops slowly. An average clear length of only 11.5 feet is common in 250 year old stands.

Rooting Habit

The ability of ponderosa pine seedlings to grow vigorous taproots is one reason for their tenacity on severe sites where other species often fail. Within a few months of germination, roots can penetrate to depths of 20 inches or more in loosened and watered soil. This rapid root growth is essential to ponderosa pine's apparent adaptation to the rough climates. Seeds do not germinate until the soil is continuously warm and moist. Over the following 2 years, lateral roots may double or triple in length.

Mature ponderosa pines put down a root to depths of more than 6 feet in porous soils, but seldom more than 3 feet in heavy clay soils. Exceptions occur in soils underlain by rock with deep fissures, where roots can grow to depths of 35 to 40 feet. In open stands, lateral roots may extend as much as150 feet. In dense stands, however, they are limited more to the crown width. The main mass of roots is concentrated within the top 24 inches.

Reaction to Competition

Because ponderosa pine is intolerant to shade, it tends to grow better in even-aged stands and is usually managed by that method. Uneven-aged stands might appear common throughout the drier portion of its range but are in reality a mosaic of even-aged groups. Ponderosa pines lose vigor in dense stands. On drier sites in the west, trees in the pole-size stands with basal area stand densities above 150 square feet per acre became subject to attack by bark beetles.

Stagnated sapling stands 70 to 100 years old usually respond to thinning and seem to grow as rapidly as properly spaced trees after the crowns have grown to sufficient size to take advantage of the growing space.

Damaging Agents

Rabbits and hares can injure or kill many seedlings in a stand. Pocket gophers, where present, are especially destructive. In areas where pocket gopher populations are high, all seedlings and many saplings may be destroyed. Squirrels and porcupines attack sapling and pole-size trees and, although rarely killing them, deform the stems on which they feed. Repeated browsing by deer stunts seedlings and in the absence of regulation, sheep and cattle damage reproduction through trampling, bedding and occasional browsing of seedlings and saplings.

At least 59 insect species attack ponderosa pine. The most damaging of these tree-killing insects are several species of *Dendroctonus*. Trees die from the combined effects of a blue stain fungus transmitted by the beetle and extensive larval consumption of the phloem. The western pine beetle (*D. brevicomis*) is a common cause of mortality in overmature trees and decadent trees within the range of ponderosa pine in Montana. During epidemics, however, trees that are apparently healthy and vigorous are also killed.

During the drought years of the 1930's, losses from western pine beetle in the west were so heavy that many foresters feared for the pine stands' continued existence. The mountain pine beetle (*D. ponderosae*) is the most destructive and aggressive enemy in the central Rocky Mountains. During the 1894-1908 outbreak in the Black Hills of South Dakota, this insect killed between 1 and 2 billion board feet of ponderosa pine. Tree killing by *D. ponderosae* has increased with the conversion of open old growth forests to dense young second growth stands.

High stand density is believed to reduce vigor of some of the larger trees in a stand and, therefore, is an underlying factor in the occurrence of bark beetle outbreaks. *D. adjunctus, D. approximatus,* and *D. valens* are other species of the genus that often kill ponderosa pine.

Among bark beetles, *Ips* species are second in destructiveness only to *Dendroctonus*. *Ips* are present naturally in all stands, where they usually breed in slash. In abundant slash from forestry activities, *Ips* can kill vigorous ponderosa pine up to 26 inches in DBH when populations reach explosive levels. Eleven species of *Ips* have been found attacking ponderosa pine. Of these, *I. latidens, I. emarginatus, I. pini, I. lecontei,* and *I. paraconfusus* have the most impact.

Several insects mine buds and shoots, primarily of young trees. Although seldom killed, trees are retarded in growth when infestations are severe. Pine tip moths (*Rhyacionia* spp.) and the gouty pitch midge (*Cecidomyia piniinopis*) kill the buds and shoots they mine. A more insidious pest is the western pineshoot borer (*Eucosma sonomana*). Larvae of this species bore within the pith of the terminal shoot, stunting but seldom killing them. Shoots that are potentially more robust are more likely to be infested than are weaker shoots. Each terminal shoot infested by a larva that developed to maturity reduces in length by more than 25% in one year.

Defoliating insects, such as the pine butterfly (*Neophasia menapia*) and the pandora moth (*Coloradia pandora*), periodically cause damage over extensive areas. The pine needle sheathminer (*Zelleria haimbachi*) can be locally severe in young stands.

Dwarf mistletoe (*Arceuthobium campylopodium*) is ponderosa pine's most widespread disease. On trees not killed, the parasite is responsible for a significant loss in growth, primarily in height, and is reported to reduce seed viability as much as 20%.

Several diseases attack ponderosa pine roots. Black stain root disease [*Leptographium wageneri*] causes a diffuse dark staining of the root wood and kills roots. *Heterobasidion annosum* causes an insidious lethal root disease that is spread by airborne spores to the surfaces of freshly-cut stumps. Both root diseases kill trees of all ages and usually result in group mortality that is sometimes mistaken for the work of bark beetles, which are frequently secondary invaders. *Armillaria* sp. can cause mortality in young plantations and thinned stands where the disease can

build up in dead root systems. Active infection centers of *L. wageneri* and *H. annosum* spread about 3 feet per year. The rate is usually less for *Armillaria* sp.

The most damaging heart rot is western red rot, caused by *Dichomitus squalens*. It is a major cause of loss of sound wood in commercial stands. Because ponderosa pines older than 100 years have substantially greater defect, shorter rotation ages can eliminate much of the heart rot problem.

A needle cast, *Elytroderma deformans*, found throughout ponderosa pine's range, is the most serious foliage disease. It is unique among the needle casts in being perennial and in its capacity to infect the host twigs, which enables it to maintain its populations even under adverse environmental conditions. Although less destructive than the appearance of the infected trees would suggest, it can slow growth and kill trees of sawtimber size. Bark beetles are prompt to attack infected trees.

Several rusts of the *Cronartium coleosporioides* complex are damaging to ponderosa pine. The western gall rust (*Endocronartium harknessii*) infects all ages of ponderosa pine, resulting in round and pear-shaped galls, distortions and trunk lesions. Young trees may be killed. Comandra blister rust (*Cronartium comandrae*) is found in Montana as well and causes scattered mortality in well-stocked sapling and small pole stands. In thinned stands, however, the disease may cause substantial damage.

Basal fire scars are common on the thick-barked stems in old growth ponderosa pine forests. Uncontrolled fire was common before European colonization. The fires burned from 1 to 47 years apart, with most at 5- to 20-year intervals. Low-intensity fires kept many ponderosa pine forests open and park-like. They also helped to maintain ponderosa pine in areas where more tolerant climax species would have attained dominance because saplings or larger-sized ponderosa pine are more fire resistant than subalpine fir or Douglas-fir.

Survival and growth of ponderosa pine are usually affected little if 50% or less of the crown is scorched in a fire. Vigorous young trees can survive when 100% of their crowns are scorched when the buds were protected by long, thin scales produced by the tree late in the fire season. Continued accumulation of food reserves after diameter growth ceases also increases the ability of the tree to withstand fire injury. When crowns are scorched, young, fast-growing trees on good sites have the best chance of survival.

Snow often injures saplings and larger trees. Stem bending and breaking from unusually wet snowfalls that overload tree crowns can seriously damage dense pole-size stands. Stem deformation by snow pressure and movement on mountain slopes is a threat to sapling stands, especially where ponderosa pine is planted above its optimum elevation limits.

Special Uses

In ponderosa pine forests, timber production, livestock grazing, and recreation are the principal land uses. Ponderosa pine forests are found at low elevations offering year-round recreation, and they frequently border forest highways where aesthetic values are high. They provide habitats for various wildlife species. Snags in the mature pine forest provide a large number of species with

nesting and roosting sites. Big game, such as deer and elk, also use the pine forests for food and shelter.

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